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J. M. WAKEMAN, - - - - - - - - President and General Manager.

CHICAGO OFFICE, - - - - - - - - - - - 936 Monadnock Block.
PHILADELPHIA OFFICE, - - - - - - - - - 929 Chestnut Street.

EUROPEAN OFFICE, - - - - - - - - A. C. SHAW, Manager.
Hastings House, Norfolk St., Strand, London, England.
PARIS, - - - - - - - - - - Electricity Building, Paris Exposition.

T. C. MARTIN AND W. D. WEAVER, - - - - - - - - - - Editors.
T. R. TALTAVALL, - - - - - - - - - - - - Associate Editor.
CARL HERING, - - - - - - - - - - - Special Contributor.

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SUPERHEATED STEAM.

That economy in the operation of the steam engine can be derived from superheated steam, was recognized in the earliest days. Almost half a century ago superheating took a very prominent place in steam engineering, and many attempts were made to profit from its use. The result, however, was a practical failure, owing to the great deterioration in the shell superheaters then employed. Corliss, however, was enabled, with the form of boiler he used, to utilize the benefits of superheating, and the great economy reported from his engine plants was undoubtedly partly to be ascribed to superheating. At the present time renewed attention is being given to the subject, and a paper presented at the Cincinnati meeting of the American Society of Mechanical Engineers, by Mr. E. H. Foster, reports a test of a pumping engine which brings out strongly the economy from the use of superheated steam. The superheater employed consisted of a single coil of about 60 sq. ft. of external heating surface to each boiler, the latter being of the Lancashire two-flue type, 6 ft. in diameter by 18 ft. long. During the test the engine indicated about 100 horse-power. With saturated steam both in the engines and jackets, the foot-pounds duty per B. T. U. was 84.63; with superheated steam both in cylinder and jackets, the duty was 97.25-ft. pounds, and with superheated steam in the engines alone, the jackets not being in use, the duty was 92.79. The steam was superheated about 125 degs. F., and effected, it will be seen, an economy of about 16 per cent. In this case the superheating was confined to the steam entering the high-pressure cylinder. It would be interesting to know the results of experiments showing the relative economy of initial superheating, combined initial and receiver superheating, and receiver superheating alone. It is quite probable that the latter would alone give very satisfactory results, and show that the apparatus for initial superheating may be dispensed with.

LONG-DISTANCE TELEPHONY.

The most important, and from several points of view, the most interesting paper presented at the Philadelphia meeting of the American Institute of Electrical Engineers, was that of Prof. Pupin on "Telephony Over Cable and Long-Distance Air Lines." The plan of the paper is most admirable, and may well be taken as a model for future papers dealing with complicated subjects. In the development of the subject, the physical conceptions are first given and illustrated by mechanical analogies. The deductions from the theoretical portion of the paper—which is wisely made to form a separate section—are then introduced and explained with reference to the phenomena involved. Next, the results of complete experimental tests of the principles established are given. These latter are so conclusive that the final or mathematical portion of the paper might have been omitted, though as a beautiful specimen of analysis its presence will be pardoned even by those who look askance at higher mathematics.

The practical value of Dr. Pupin's paper lies in its theoretical and experimental demonstration that at little expense and with simple means a practical equivalent of Heaviside's distortionless conductor is possible. That is, by a proper disposition of inductance along a line, the attenuation and distortion of telephonic currents may be reduced to a minimum. It has, of course, been long known that the distortional effect of a telephone line could be controlled by maintaining cer-

tain relations between the capacity, inductance and resistance of the line. These relations, however, have been stated in terms of distributed inductance; or, at least, it has not been shown that a distortionless or uniform conductor could be approximated to within a definite limit by an equally definite distribution of inductance coils along a line. It is true that experiments have been made to test the efficacy of the introduction of such coils in a line, but lacking a theoretical guide, failure has been the result. Prof. Pupin points out very clearly the reason for such failure, for if the inductance introduced has not its proper value and is not distributed in a perfectly definite relation, the phenomenon of reflection occurs. That is to say, the inductance itself becomes a source of secondary waves which react on the line, thus increasing rather than decreasing its effectiveness. Dr. Pupin, basing his mathematical analysis upon the theory of wave propagation, establishes a simple law which determines the degree of equivalence between a non-uniform conductor—or a line in which inductances are inserted at intervals—and a uniform conductor; and by means of the formulas deduced, the value and distribution of the inductances along a line for an allowable attenuation may be exactly calculated.

The interest of the paper would have been much enhanced had the commercial bearing of the law deduced been set forth by definite statements as to the effect of its application on the design of long-distance telephone lines—that is, the probability of substituting ordinary telegraph wire for the present expensive copper conductors of large sectional area. This probability would appear to be a deduction from the principles established, for the attenuation factor shows that an increase of inductance will compensate for an increase of resistance; and the law indicates how the increased inductance may be inserted into the line in a manner not to introduce ill effects of itself.

THE PHILADELPHIA MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The June meeting of the Institute recently held in Philadelphia will long be remembered as very successful, not only in its technical, but also in its social features. Some good papers were read and equally good discussions evoked. It is curious that three of the papers dealt with the same problem from three different standpoints; namely, the problem of transmitting electric power to long distances. One of these papers dealt with this subject directly on a large scale in connection with overhead aluminum conductors for the transmission of large quantities of power. The second dealt with the subject from the standpoint of telephony, and the third from the point of view of submarine telegraphy; in each case the basis of operation was placed upon alternating currents of the sinusoidal type. The transmission of power on a large scale is generally admitted to be most readily effected by the alternating current, and the only question as to the system employed depends upon the local circumstances of each particular case. With telephony an alternating current is an unalterable necessity, but in the case of submarine telegraphy it is an innovation. The battery with its rectangular form of impressed wave has hitherto always dominated the telegraphic field. Since on a long cable the received currents are practically those due to the fundamental frequency, after all the harmonics have been absorbed—or, in other words, after all the corners have been rounded off the wave, practically leaving the simple sine wave as the residuum—it is manifestly distinctly advantageous to employ a sine wave at the generator, on the basis of transmitting power over a submarine cable.

As a matter of fact, however, although power is needed to operate a siphon recorder, this receiving instrument is neither a wattmeter nor a motor, and its operation depends upon the production of legible signals as interpreted by a trained operator. It takes about six months to train the eye of a cable operator so as to read siphon recorder signals at usual speeds. Moreover, the letters of the alphabet and their code signals are such that the transmitted signals are very heterogeneous in their character, sometimes being alternately positive and negative, and at other times either entirely positive or entirely negative for several successive impulses. Such groups are necessarily subject to distortion in varying degrees, and the real problem is, therefore, to transmit impulses subject to distortion in such a manner that a trained eye can decipher them with security. Under these circumstances the relative advantage of sinusoidal waves over rectangular waves is apparently somewhat reduced, and can only be determined by practical trial on an extended scale.

It is curious to observe, however, that the transmission of power by alternating currents includes arts apparently so distinct and relatively remote as submarine telegraphy, long-distance telephone and distant street-car driving. It is also interesting to notice that, more than 30 years ago, the generators employed in land-line telegraphy were occasionally hand-dynamos, consisting of a magneto, the armature of which was manipulated in an up-and-down manner by hand, so as to send the required electrical impulses. These magneto instruments have, however, almost entirely disappeared, being cumbrous and not being capable of ready adjustment in the magnitude of the electromotive force they would develop. In England the Wheatstone A-B-C instruments have been operated for many years by rotating a handle with the left hand and manipulating a keyboard with the right. The rotating handle revolves a little magneto armature or inductor for generating alternating-current impulses. An alternator connected through a punched tape with a submarine cable is, however, a novel and interesting combination.

THE BRITISH INSTITUTION OF ELECTRICAL ENGINEERS.

The April number of the *Journal* of the Institution of Electrical Engineers in London, shows that that body has apparently followed the lead of the American Institute of Electrical Engineers in establishing local branches in cities where there may be a sufficiently large membership to make meetings successful. Following the report of the paper read in London, there is a paper read at the Glasgow local section and an inaugural address of the chairman of the Dublin local section. It would seem, however, that whereas it is the rule in the American Institute to read the same papers both at the New York meeting and at the local meetings, our transatlantic cousins leave their local sections entirely free as to what papers they shall read or discuss, and merely embody the local papers in the *Transactions* of the Institute if they are found to possess sufficient merit.

Prof. Fitzgerald's inaugural address to the Dublin section is a plea for applied science and its endowment. He briefly reviews the history of epoch-making physical inventions and applications of the century and differentiates between those which rapidly came into commercial application and those which, on the contrary, required much time to develop and employ. The reason advanced for this difference in rate of application is that those in the former class could be immediately utilized on a small scale and required but little and inexpensive experimentation to use on that scale; whereas, those in the latter class could only be utilized when applied on a large scale, and the experimentation required was so costly as to defer all attempts at practical adoption. The argument is made that colleges and physical laboratories should be more generously endowed for the purposes of developing the discoveries in applied science.

It seems to us that while the plea is sound and unimpeachable,

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there is a hiatus in the argument. It is obvious that as knowledge and civilization expand, the growth of the one depends ever more closely upon the growth of the other; consequently, it yearly becomes of more importance to develop and foster discoveries pertaining to physics and chemistry in universities and college laboratories. It is doubtful, however, whether such institutions can not only bring forth the discoveries but also bring them up and adapt them in such a manner as to make them suitable for practical and commercial use. In other words, it seems doubtful whether practical applications would not require to be elaborated outside of educational establishments, even if the endowments of their laboratories were ten times as great as they are to-day. We think that while the laboratories should be plentifully endowed, that such endowment would be amply remunerative to the community in the increase of knowledge or in the added discoveries which must always attend research; but that the application of those discoveries must be made, as usual, by persons in contact with industrial life, as distinguished from educational life.

NAMES FOR ELECTROSTATIC AND ELECTROMAGNETIC UNITS.

At the recent general meeting of the American Institute of Electrical Engineers in Philadelphia, it was resolved to urge upon the International Electrical Congress, due to meet this year in Paris, the importance of giving names to the fundamental centimetre-gramme-second units in the electrostatic and electromagnetic systems. It is a remarkable fact that although we possess an excellent system of electromagnetic units based upon the centimetre, gramme and second, which system is internationally used in all physical measurements and applications, these units have no names; on the other hand, in the practical system based upon the quadrant, second, and hundred-millionth of a milligramme, the principal units have names. If the centimetre-gramme-second units were vicious, useless and destined to perdition, this condition of affairs would be right and proper; but seeing that the practical system of units is relatively unfitted for physical measurements, and that the centimetre-gramme-second units are much used, and are excellently adapted for such use, the condition of affairs seems illogical to the verge of incongruity.

No one can reasonably declare that there would be any harm done by giving names to the C. G. S. units. In human affairs everything is worthy of a name. If the thing is of little importance the name is insignificant; while if the thing is worthy, the name becomes prominent. But an important thing which is also anonymous is an illusion and an inconsistency. There would be great advantage in giving names to these units if only for the reason that there exists a dual C. G. S. system; viz., the electromagnetic and the electrostatic, and that it is ambiguous to speak of the magnitude as being, say, 5000 C. G. S. units, since the statement may refer either to the magnetic units or to the static units. A proper system of names would eliminate this source of uncertainty. A reference to the pages of such writings as appear in the *Philosophical Magazine*, the *Physical Review* and the *Transactions* of the various Physical Societies, will satisfy any unbiased person that such uncertainty does exist at the present time.

It is alleged that names are not wanted because they would be so burdensome to the memory. This seems to be a wail of inertia, and would apply to every advance that science has ever made. It is said that there are 1500 millions of living human beings. So far as we know, they all, or nearly all, have names; it is no hardship to the community that there should be this large number of names in existence. No one is obliged to learn them, or any of them against his will. There are thousands of species of plants and animals either existant, or no longer existant, which have names. Some of these names are fit subjects of terror to the unenlightened, but the names possess recognized utility. In chemistry, mineralogy and physiology there are thousands of polysyllabic names whose existence is an evident utility, and whose diversity causes distress to no unoffending member of the community. With what assurance then can it be declared that a few internationally adopted names for the fundamental entities of electromagnetics could cause general distress. It is also alleged that because names have been given in the practical quadrant-eleventhet-gramme-second system, that names in the fundamental centimetre-gramme-second system would be redundant or confusing. This is a valid argument, unless care be taken in bestowing the new names. If the new names are properly selected no such confusion should arise. For example, the ohm is the name of 10^9 C. G. S. magnetic units of resistance. The C. G. S. unit itself might, for example, be called the *neohm*. The prefix *ne* would then distinguish between the fundamental and the practical unit. A similar course could be followed with the other units of the magnetic system. No electrician would have to learn the new names, he would already know them, after the prefix *ne* had been agreed upon and made known. It seems desirable, however, that the C. G. S. names should not exceed two syllables in length, and, consequently, such names as coulomb and farad might be advantageously shortened, say, to coul and frad, for example, in forming new terms, such as *necoul* and *nefrad*.

After the C. G. S. names had been selected, a proper and adequate list of decimal multiples and sub-multiples should be agreed upon. At present in the descending and ascending scales we have names for the powers to six, except the plus fifth and minus fourth and fifth powers. In a proper and logical scientific terminology, there should be names for every power of ten as a multiple in both descending and ascending scales from 1 to at least 20, inclusive. In other words, the present scheme should not only have its blanks filled up but should also be extended to twenty places. Such prefixes should not exceed two syllables in length. Thus, if the prefix for 10^9 should be, say, okto, then the ohm would be the same magnitude as the oktoneohm on the above-suggested basis. All practical men could go on using the ohm just as at present, while students and physicists would be at liberty either to use ohms or neohms. It is unworthy of scientific terminology at the close of the nineteenth century that no international system of prefixes or suffixes exists for expressing decimal multiples beyond the first two or three places. If, however, it should be considered that a complete table of decimal places would be too cumbersome to remember or introduce, a table should at least be prepared and agreed upon with every third place agreed upon. In other words, names should be given to the powers 10^{-9}, 10^{-12}, 10^{-15}, 10^{-18}, etc., and 10^{9}, 10^{12}, 10^{15}, 10^{18}, etc. The terms *ninethet, twelfthet,* etc., already suggested and in some use, are only suitable for the English language.

If such names and prefixes were adopted by the International Electrical Congress no harm could ensue, while a distinct step forward would have been made in international technology and terminology. If this step had been taken originally there would not have been any occasion for the development of the practical quadrant-eleventhet-gramme-second system, and much unnecessary reduplication, trouble and confusion would have been saved. As to whether the electric and magnetic units can be rationalized or whether in view of the labor and difficulty would attend the process, such rationalization should be effected, is an entirely separate question. It is a much more serious question than the mere christening of units, that have been in current use for the last thirty years. It would require a general consensus of opinion to bring about. But the matter appears to be of sufficient importance to warrant its being brought before the attention of the Electrical Congress.

Some Aspects of the Pacific Cables Question.

BY FREDERICK TRIMMER.

THERE would appear to be no difference of opinion in Congress upon the main question of connecting the nation's recent acquisitions scattered across the Pacific with this continent, but the national legislature has been unable so far to decide what will be the wisest plan to proceed upon and the matter still remains in controversy.

Shall the Government undertake the work and retain the whole thing in its own control, both during laying and for operation after this has been effected; or shall Congress merely vote a subsidy to some private concern to establish and maintain the required communication with these outposts?

To the casual onlooker the subject may appear to be one having but little interest for the general public—one to be regarded merely as a passing incident of the military operations that the nation is just now engaged in; but a more careful study of the situation will show that some important considerations are presented of both a business and sentimental nature.

The patriotic American cartographer in drafting his map of the world places this continent in the middle of the picture as representing to his mind its rightful place as the centre of the world's activities. The European in making the same map places this continent to one side. With the closing of this gap in communication over the Pacific the logic of the American map maker's contention, and the commanding geographical position of this continent, lying as it does midway between the old world and the new rising worlds bordering on the Pacific Ocean to the north and south of the equator, will be realized.

Practical considerations of interest to the mercantile community are the reductions foreshadowed in point of time in transmission of messages between the two countries, and reduction in cost, to which considerations may be added the assurance of fewer repetitions and errors in transmission. A message passing between New York and Shanghai over the present route is subject to retransmission at some 13 or 14 different points, and as every added repetition means added risk of error to the text, involving, where errors do occur, delay and possibly serious pecuniary loss to those in correspondence, the advantage is manifestly with the route which can reduce retransmission to a minimum.

The closing of this telegraphic gap between San Francisco and Manila should reduce the number of retransmissions on correspondence originating at Atlantic seaboard centres and directed to the Far East, by one-half, and should even offer advantages to European correspondence for the same destination. For, although the telegraphic mileage over the present route from London to Hong Kong, taking the last as the Far East business centre, is less than the mileage will be over the new route to be opened this way, the advantage will still be with this route in respect of fewer retransmissions, for the reason that the American route divides up for operating into sections of greater length.

American agencies for European news are doubtless interested spectators of events in Washington, as the establishment of this new telegraphic connection will in the nature of things open to them the field on the other side of the Pacific, and one possibly in Australia as well. The Far Eastern field, it may be supposed, will fall into their hands without the necessity for a struggle, but the more remote Australian field will not be reached so easily. Correspondence from the Pacific Coast destined for Australia will join the outgoing stream from London, passing round the world the other way at Singapore, and the time taken by messages between London and Singapore will probably be about the same, whether the message goes under the Pacific or under the Mediterranean. Thus, European news distributed by the papers hot for the San Francisco breakfast may presently be served as a réchauffé at Sydney and Melbourne breakfasts of the same sunrise though called to-morrow. The schedule rate for press messages from London to Melbourne is 44 cents per word.

These are some of the features presented by this subject, which are of interest from the American point of view, but there are interests abroad which by no means harmonize with them—interests which will probably view the laying of this cable with about as much satisfaction as some happily-situated railway, enjoying what had seemed to be an exclusive territory, would regard the entrance into its field of a strong rival and the installing of an ambitious young freight agent to bid for the business it had come to consider as peculiarly its own.

Nowhere in the world's long-distance telegraphic communications is there a gap, the closing of which would operate more distinctly as a disturber of established conditions than this gap over the Pacific, as a glance at the present schedule of charges will show. From London to San Francisco, a distance of six thousand miles, the rate per word comes to 35 cents, and San Francisco is half-way to Hong Kong. From London to Hong Kong by the existing route the rate per word is $1.68. Will the American business community agree to a high rate across the Pacific after this cable has been laid? If they will not, it would appear to be inevitable that the new route will draw all the business from the old one until such time as the directors of the old companies see their way to meet the situation. The outlook ahead for some of these older companies seems to be a little clouded, and is probably receiving in London all the attention that it deserves. But lower rates commonly mean a proportionate increase of business, and as cables on routes remote from main lines of correspondence East and West are often only partially employed, more business can generally be carried without any increase of outlay, giving the public the advantage of lower rates without detriment to vested enterprise.

Long-distance telegraphing means a rate per word so high that the opportunity is created for certain agencies to do a profitable business by coding messages written in plain language and left with them by the public, which messages the agency accepts the transmission of at a rate somewhat lower than the schedule. Merchants corresponding regularly have their own codes, but there are many persons whose correspondence is irregular and who only use the cables in emergencies. The profits of such agencies consist in the shortening of the messages left with them. There was a time when messages bearing the names of some of the more prominent of these agencies seemed to receive favors and managed to get through quicker than messages from the general public, but with the disappearance of competition between rival lines consequent upon a general pooling of interests, this has passed away.

Agencies of this kind are not usually concerned with changes in the schedule, but it would seem as though these prospective changes ahead might interest them, as this new route will not be governed by the international convention as are other lines operating through the East. Visions of rate-cutting and other disturbing features may possibly have presented themselves to the minds of those long established in the business.

Thus, it would appear that there are well-established interests abroad which must be watching with no little interest the course of events just now at Washington.

This article does not purport to do more than call attention to some of the business aspects in this case, but there is a side aspect upon which a passing observation might be offered, and that is the incentive which the retention of this cable in Government control might give to American inventive genius in a field now virtually one closed to the inventor.

The transmission of electric currents through long submerged wires presents problems that are absent in air lines, and the practical difficulties to be contended with can hardly be understood without experience in cable operations. For twenty years practically no improvements have been made in the appliances used for transmitting and recording signals through submerged wires. A belief seems to have settled on the minds of those within reach of the means for making experiment that the limit of possibilities has been reached. The inventor is shut out and the door bolted, but with a benevolent government in control of these cables, the bars might be taken down and a new spirit of inquiry aroused.

Trolley Express Service.

Trolley express service was recently inaugurated on some of the Connecticut electric railways, the district between Stamford and New Haven, and Bridgeport and Ansonia being thus covered. The service will be largely used by farmers and fruit growers, who may thus send their goods directly to market without delay or danger of perishing. Stations will be established in each town through which the trolley passes, and an agent with horse and wagon will meet the cars on each trip and deliver all goods. Two trips will be made each way on week days. Three large cars have been especially constructed for the service. They resemble express cars of steam roads and are provided with safes for the storage of money and valuables.

The Electric Light Plant of Malta.

BY R. W. ASHCROFT.

THE Maltese Islands consist of Malta, Gozo, Comino and Cominotto. Of these four, Malta is, of course, by far the most important. This famous island, rightly named the watch tower of the Mediterranean, measures but 20 miles in length and 12 miles in breadth, and has an area of about 98 square miles. Sicily is 50 miles to the North, and the nearest point in Africa is about 180 miles due South. As will be seen by reference to any map of Europe, the geographical situation of the island is such as to render it a most important commercial station. It is a port of call for most of the craft plying in or through the Mediterranean. The island, which now is a British colony, is exceedingly well fortified and is the principal rendezvous in the Mediterranean for the warships of England. At all times one will see the harbor full of cruisers, battleships, torpedo boats and other fighting craft. Valletta is the capital of the island, and stands on a promontory forming a sort of ridge about 110 ft. high. Some of the streets are naturally so steep that the sidewalks are made in the form of steps, and sometimes the whole street consists of these steps.

The electric light plant is located in a building in the "Marina," or street bordering the harbor. Both the foundations and the superstructure of the building are of stone, built on solid rock. The roof, of flat construction, is also of stone, and is supported on iron beams. The building, before being used as the station, was an oil vat, built in the year 1745 by Grand Master Emmaneul Pinto.

The plant was installed and is operated by the Maltese Government. The supply was started on Dec. 1, 1896, and the plant has been running continuously since then. The entire work of installation was carried out by the Brush Electrical Engineering Company, of London, England. Alternating current is generated at 2200 volts and a frequency of 100 p. p. s. The total capacity of the plant is 575 kilowatts, furnished by six main engines (compound vertical) and two bipolar exciters. The largest engine is a Raworth's universal enclosed of 300 horse-power at 250 r. p. m. (Fig. 2.) There are also three 150-hp engines of the Brush marine open type, running at 231 r. p. m. In addition to these, there is one 75 horse-power (275 r. p. m.) and one 35 horse-power (300 r. p. m.) of the same type as the 150-hp engines. The two exciters are driven by Brush tandem engines running at 325 r. p. m. The alternators are of the Mordey type with stationary armature, and are run in parallel. Both alternators and exciters are direct-coupled through Raworth patent flexible couplings. The view of the main engine here given was taken before the 200 kilowatt set was installed.

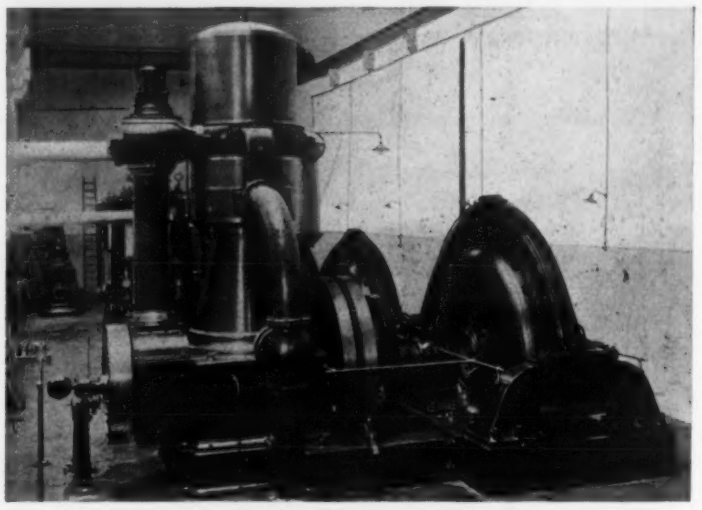


FIG. 2.—200-KW GENERATING SET, MALTA STATION.

The switchboard is the Brush Company's standard type, with slate panels and teak frame, consisting of two exciter panels, six alternator panels, one synchronizer panel, one meter panel and six

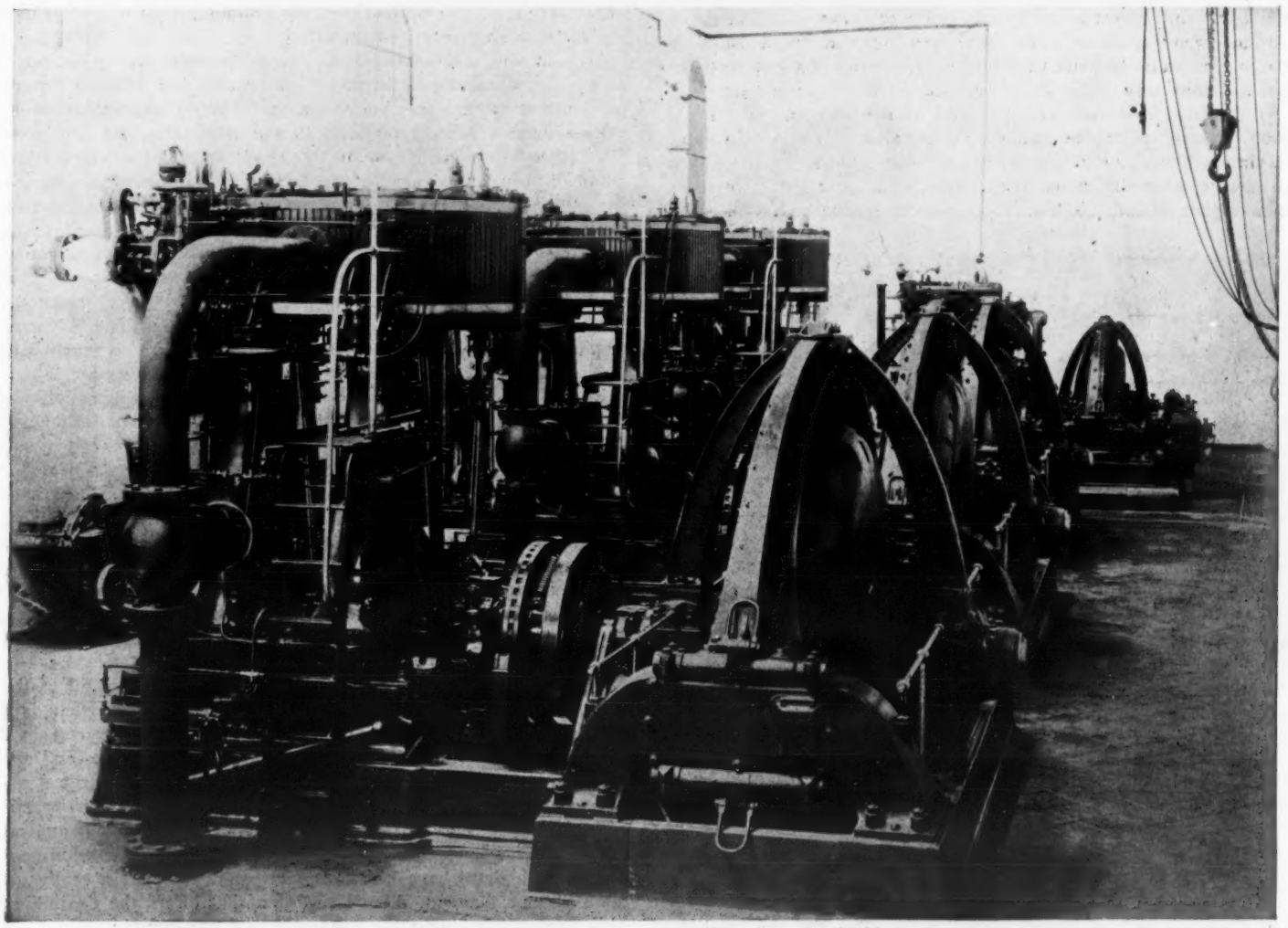


FIG. 1.—VIEW OF GENERATING ROOM, MALTA STATION.

feeder panels. The switchboard platform is raised 4 ft. above the engine room floor level. The testing room is behind the switchboard, and contains all necessary instruments for testing the mains, machines, meters, lamps, etc.

In the boiler house are four Babcock & Wilcox water-tube boilers of 300 horse-power each, which are hand fired with Welsh steam coal, costing $6.75 per ton delivered in the harbor. Two feed pumps of Worthington make and one injector are also used for boiler

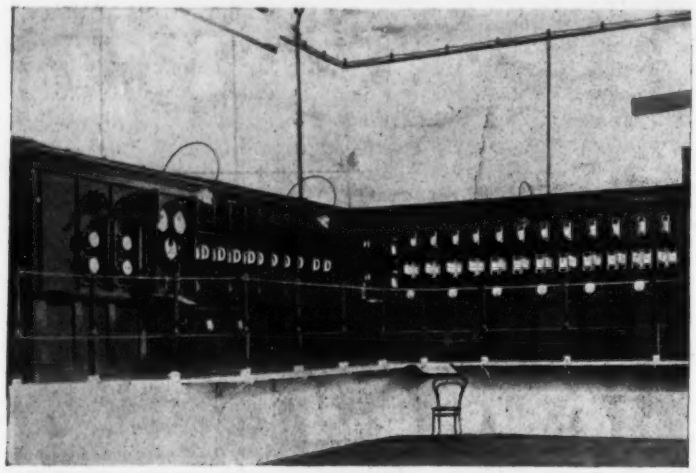


FIG. 3.—SWITCHBOARD—MACHINE PANELS ON THE LEFT, FEEDER PANELS ON THE RIGHT.

feeding. The water used in the boilers is at present taken from the town mains. The steam main is of the King type with Hopkinson parallel valves, and is drained by means of Geipel steam traps, one of which is also attached to each of the engines. All feed pipes, etc., are in duplicate. The steam pressure averages 135 lbs. per square inch. A Ledward ejector condenser is at present in use taking water from the harbor; a surface condenser, exhaust steam evaporator and Edwards' air pumps are now being installed.

About twenty miles of mains have been laid and are in use. The type of the mains is concentric lead-covered and armored with two layers of steel tape. The mains are laid direct in the ground.

At present there are fifty-two transformer sub-stations in use. Some of them are located under the sidewalks, and others in public buildings. The transformers used are of the Mordey type. There are seventy-seven arc lamps in daily use, each having its own transformer in the base of the post. The arc lamps are the open type, Brush,

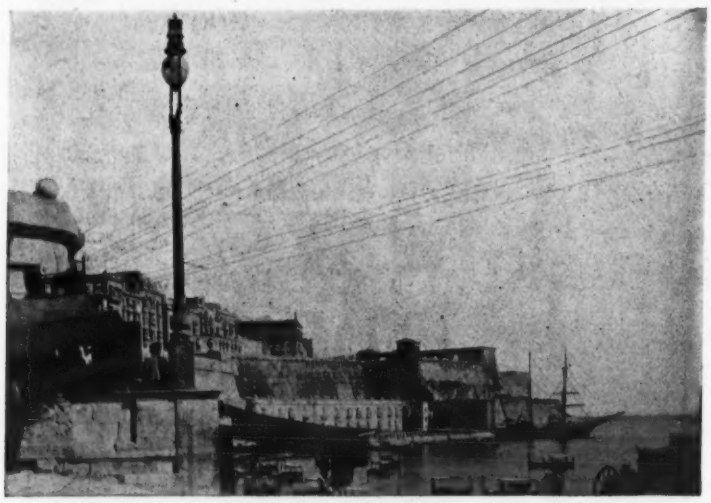


FIG. 4.—ONE OF THE HARBOR ARC LIGHTS.

Vienna make. The main streets and the harbor are lighted by arc lamps, while the side streets receive their illumination from 32-cp incandescent lights. The voltage at consumers' terminals is 100 to 105. The total connections up to March, 1900, amount to an equivalent of 11,000 8-cp lamps.

The street lighting mains are separate from the house supply mains. The price per unit for private supply is 12 cents, and for consumers of over fifty 8-cp lamps, 10 cents per kw-hour. Power is supplied at 8 cents per kw-hour. Thomson-Houston meters are used for the measurement of the consumption of current. Gas—a very poor article of Maltese manufacture—does not constitute a very strong competitor to the electric light plant, although it is an industry of older date. The prevailing charge is $1.04 per 1000 cu. ft.

The chief of the engineering staff is at present Mr. G. E. Muller. He is assisted by Messrs. C. M. Read, A. Portelli and R. Mizziani. Supplies are purchased through the Crown Agency, at London, and preference has so far been given to goods of British manufacture.

In addition to the electric light plant, there is a small telephone exchange in Valletta, owned and operated by Mr. Robert Portelli, the father of the A. Portelli mentioned above. Mr. Portelli is also manager of the Malta station of the Eastern Telegraph Company.

500-Volt Lamps.

By Alexis Werner and Jos. Hardwick.

DURING the past two or three months the writers have been experimenting with considerable success on a high-voltage filament for electric incandescent lamps, and the following account of the work done may be of some interest. Up to the present time this has been a very difficult problem. High-voltage lamps of ordinary candle-powers cannot successfully be made with carbon filaments, for incandescent carbon is a comparatively good conductor and the filament has to be so thin as to be very weak.

We started with the idea of making a compound filament, using some metal to carry the current and some non-conducting substance as a mechanical support for the metal. This arrangement would allow us to vary the voltage and the mechanical strength at will. We worked with all the metals that have high fusion points, especially with iridium, osmium, ruthenium and rhodium. The rare earths were generally used for the non-conducting mechanical support because of their high fusion points.

Contrary to the general belief, it is possible to obtain considerable mechanical strength and flexibility in these substances by making careful combinations, and we got a very good support with magnesia and alumina and with thoria and didimium oxide. Though the substances used varied, as above stated, and many different experiments were tried, the method used for making a filament with iridium will serve as an illustration for all.

A compound solution was made of an iridium salt and a nitrate of some rare earth. A thread of cotton or other suitable material was soaked in this solution, dried and burned thoroughly over a bunsen flame. After mounting on the wire terminals, we passed through the filament a current about double that for which it was intended in order to burn out the last of the carbon remaining from the thread. We found this careful burning necessary because iridium forms a carbide difficult to decompose, and a great deal of experimenting developed the fact that if this carbide was present during exhaustion, the Edison effect was greatly increased, the bulb was blackened and the spectroscope showed the presence of carbon vapor. When the metal used was iridium alone, a vacuum was not necessary, of course, but the economy was so much better that we generally did exhaust the lamps.

In our later experiments we electroplated the iridium and oxide filament, prepared as above, with osmium to raise its fusion point and so allow of increasing its efficiency, and the presence of osmium made exhaustion necessary the same as for a carbon filament.

Some filaments were made also by a mechanical rather than a chemical combination of conducting and non-conducting substances. In this case one thread was soaked in a solution of some iridium salt and another in a solution of the nitrate of some of the rare earths. These threads were then twisted or braided together and dried and burned, as in the process already described. The resulting filament seemed strong and practical, but it was not so easy to obtain voltages above 200 or to make small variations in resistance.

At varying degrees of incandescence the resistance of all of these metallic filaments remained much more nearly constant than is the case with carbon filaments, and as the charge was, of course, in the opposite direction—increasing as they were heated—there was much less danger of the lamp being injured by fluctuations in the e. m. f. even when it was 500 or 1000 volts across its terminals. The practical influxibility and high resistance of this filament will make it applicable to the Nernst lamp for the preliminary heating of the oxide pencil.

Although there have been many attempts to make a really good high voltage filament, there is no plan that offers the flexibility of this one, of combining the conductor and non-conductor in a solution in which the different ingredients may be perfectly mixed and evenly applied, no matter how they may differ in proportions.

Some Electrical Art Features at the Exposition.

ALL the official buildings of the Paris exposition, i. e., all which have been put up by the authorities, carry decoration in some form. In many, a large amount of beautiful frescoing is to be seen, in others the mural panels are ceramics. There is an abundance of statuary of heroic proportions, fine in design and rich in effect, but all modeled out of the staff that is the exterior surface for every structure. An admirable example of such sculptural work is to be seen upon the façade and niche of the beautiful Chateau d'Eau, but it is in fact difficult to escape anywhere the piece of art with which it has been intended to sum up or suggest the special object of the building where it is placed.

At the very entrance to the Exposition, the Monumental Gate opening upon the Place de la Concorde, one is confronted by two colossal figures intended to be symbolic or suggestive in some way of electricity. This Gate stands at an angle to the Place and to the thoroughfare known as the Cours la Reine, and rising to a height of over 100 ft. is divided into three equally-sized arches which meet in a dome. The approaches to the Gate are high converging walls covered with friezes to illustrate human toil, and in one of the two huge panels a group of men with a dynamo are particularly conspicuous. Close to the Gate along the lines of these walls rise two elaborate columns each over 100 ft. high carrying an electric light at the top, and immediately within the entrance, flanking each side of the gateway, are two colossal pedestals. Upon each of these stands an immense figure of a woman. Each statue is intended by M. Jondet to represent the Spirit or Goddess of Electricity. The woman stands upon electromagnets, the attributes and sources of her power. A tightly fitting tunic covers the upper body and is imitated from the dress of the Assyrian magi. The robe around the lower part of the body is covered with metallic finish in such a way as to suggest the play of electric fires, the color scheme being bluish-green and yellow, with an idea perhaps of getting an effect something like that to be seen in vacuum tubes. A diadem rests on the head to attest sovereignty, and in each hand are gifts, whose design is a little too esoteric to be comprehended even by the expert electrician. The expression of the face is severe and strong, and altogether the statues are very striking even if they are not greatly to be admired for mere beauty.

One of the features of the stately and beautiful Salle des Fêtes is its decoration, upon which some of the leading artists of France have expended their finest thought and efforts. Here again everything is on a heroic scale. As has already been noted in these pages, this building is enclosed within another building, now the Agricultural, but in 1889 the Machinery Hall, where for the first time American apparatus made a collective appearance in such wise as to let it be understood that a time had been reached when it also could command the markets of the world. But although only an inner building, the Salle des Fêtes will, it is said, seat some 15,000 people and accommodate 20,000, so that statuary, paintings, decorations are all in proportion to the vast area, and can be seen to advantage from any point of the floor or the galleries. The Salle is ceiled with a superb dome of stained glass, and the provision for lighting is 4500 incandescent lamps. Immediately below the glass dome, around the space above the arched galleries and the tribunes extend a series of four large and four smaller panels of canvas paintings applied to the structure. The smaller panels represent the seasons, the larger ones are typical of arts and industries, and were executed by Messrs. Eugene Cormon, G. Rochegrosse and F. Maignan. It is by the one devoted to Electricity, Forges, Mines and Civil Engineering that the attention of the engineer is specially held. We reproduce here that portion of the painting treating of electricity, and occupying the left portion of the colossal canvas. The artist of this and other groups,

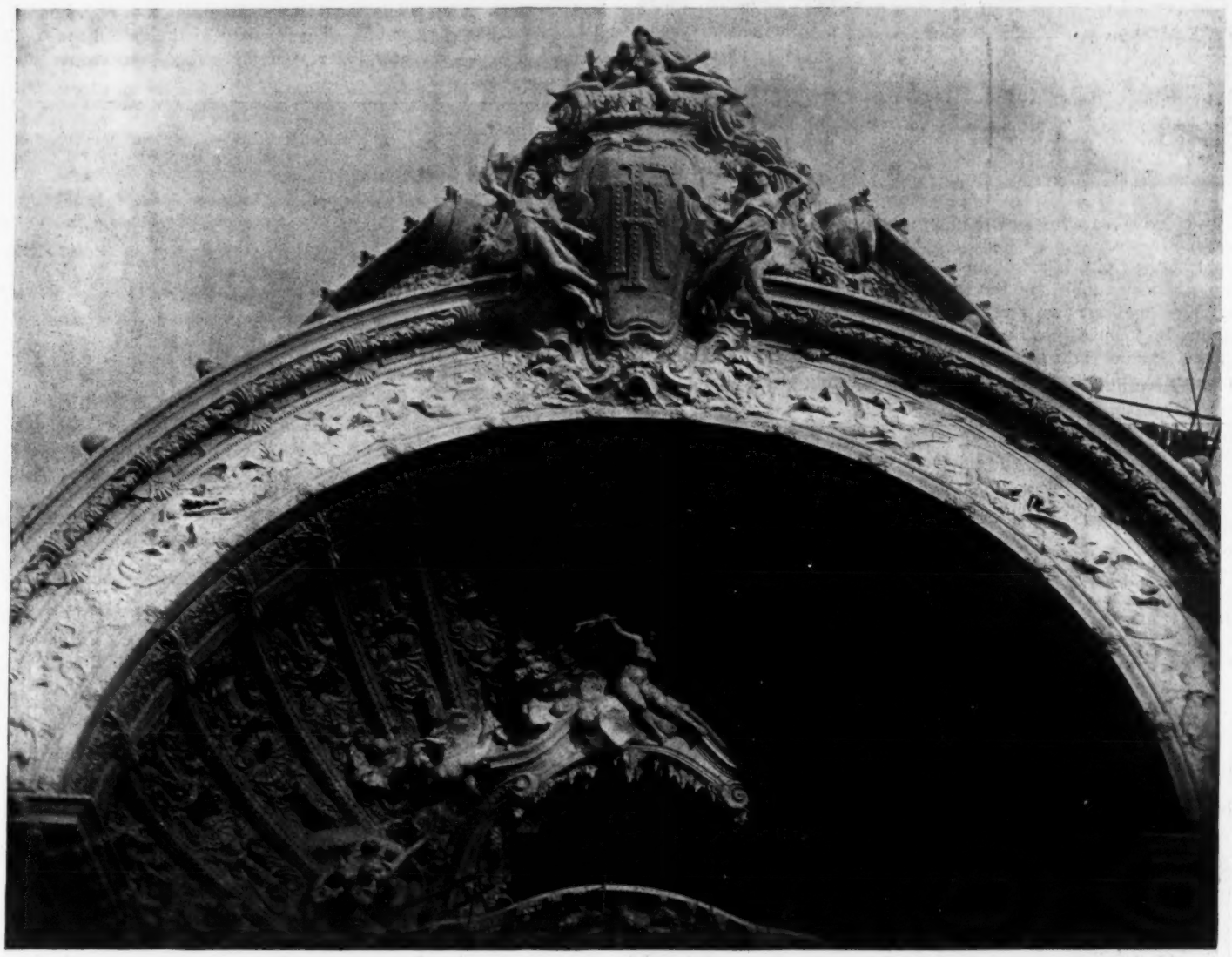


FIG. 1.—UPPER FAÇADE AND NICHE OF CHATEAU D'EAU, SHOWING RECEIVING TANK AND CARTOUCHE WITH ILLUMINATED INITIALS OF REPUBLIC.

M. Cormon, has done an excellent piece of work, which creates a pleasing effect from whatever point of view it may be witnessed. In

FIG. 2.—STATUE IN NICHE OF MONUMENTAL ENTRANCE.

front at the right, is a woman at the telephone, and behind her are two others at a table, one sending a telegraph message and the other writing a message just received on the tape of the register—for receiving by sound is not regarded at all with official favor in Europe. At the extreme right is a switchboard with switch and recording instruments, while in the rear are poles supporting electric lamps. To

FIG. 3.—DECORATION ON SIDE OF MAIN ARCH, CHATEAU D'EAU.

the left, in front, is a dynamo with its tender, and at the back passes an electric automobile. The artist has not sought to be very precise in his rendering of the apparatus, but rather to secure a harmonious effect which in itself neither a telegraph office nor a dynamo room would afford.

Just below the pictures in this group some very fine "conventional" groups of electrical, mechanical and engineering apparatus have been worked up in plaster, in high relief, so as to constitute in some degree an ornamental frame to the canvases, and merge them into the general scheme of the vast dome.

The whole front of the Chateau d' Eau is a mass of elaborate ornamentation, set off and supplemented by that of Electricity Building immediately in the rear. Here Messrs. Hénard and Paulin have indulged in some very graceful fancies, to which the border of Electricity Building serves as a relief, its crest looking by day like a carving of fine lace in stone and being at night touched up by electric light. The central artistic "motif" of the building is a large panel carrying the date "1900," above which is a beautiful figure symbolic of the Genius of Electricity, mounted in a chariot drawn by hippogriphs, and brandishing aloft the torch of progress. Around the back of the figure are clustered hundreds of incandescent lamps in the rays of a huge star. Coming forward to the vast niche of the Chateau d'Eau—or Water Palace—we find every inch of space cov-

FIG. 4.—ELECTRICITY PANEL, SALLE DES FÊTES, CHAMP DE MARS.

ered with statuary and decoration. The figures in high relief are quite numerous. At the top of the whole recess or niche from which the water descends is a large cartouche or shield bearing the initials of the French Republic—"R. F."—and the double scroll of the edge leads down to two colossal columns shaped as vases and profusely ornamented. All about the cascade as it leaves its mountain cave or spring above are sirens, tritons and marine divinities, and at the centre of the first receiving basin is an allegorical group of Humanity led by Progress advancing toward the full sunshine of the Future and hurling into the foam of the sea of Oblivion two Furies representing Routine and Superstition. Complementing all this are panels, reliefs, scrolls and fountain mouths, the whole carried out with amazing beauty and vigor, and constituting without doubt the most wonderful and artistic cascade man has ever created. At the Chicago World's Fair, as will be remembered, the central water effects on the Grand Court of Honor were those of spouting fountains, flanking the Neptune group, which had a cascade of but a few feet fall. At Paris, the artistic effect is entirely different, being that of a cascade falling 100 ft. down the front of a building. Preference for one method or the other will be a matter of individual taste. The object here is simply to emphasize not the water effects, but the artistic treatment rendered necessary by the scheme adopted. It will have been seen from the views herewith, if not from the description, that a brilliant piece of work has been produced, in harmonious relation to the scenic environment. What makes the Water Palace more pleasing and gratifying to the engineer is that it is in reality after all but a part of the plant for furnishing water for steam and condensation to the boilers and engines behind it. But no one looking at its loveliness, either by the light of day, or under the soft electric illumination of night, would suspect any such humble purpose.

The interior decoration of the building is in general tasteful, but not especially decorative, the decorations having been left to the in-

dividual exhibitor or to the country within whose section at any point he appears. In some places, however, the opportunity has occurred or the necessity arisen, for artistic treatment, as in the gallery

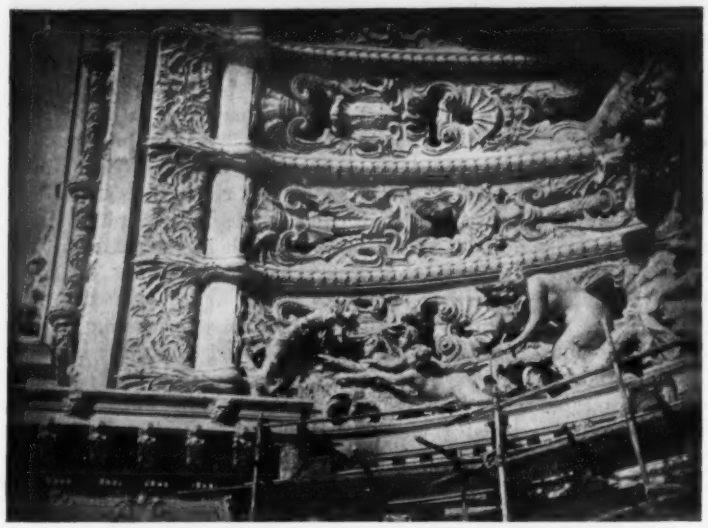


FIG. 5.—SCHEME OF DECORATION, INTERIOR OF ARCH, CHATEAU D'EAU.

of Electricity Building, known as the Court of Honor. Here various countries have created some very fine courts for their electrical and mechanical relics of invention. That of the United States has the most prominent position, and is certainly unsurpassed in beauty. The environment is also excellent, as shown by the manner in which the large panels of the surrounding walls have been treated. While some of them have long lists of the names of electrical worthies painted in entablature, others give the designation of the building in a very striking and dignified scheme of decoration.

EXPOSITION NOTES.

RUSHING THINGS.—M. Millerand, Minister of Commerce, etc., and M. Picard, Director-General of the Exposition, have taken joint action this week, May 12, to see if matters cannot be in some degree

FIG. 6.—DECORATIVE PANEL, SALON D'HONNEUR, ELECTRICITY BUILDING.

expedited at the show, and a positive order has gone forth that after that day no more exhibits shall be admitted to the grounds. It will be extremely difficult to enforce this rule in every case, but the immediate result has been a great rush of goods into the grounds, and in many places a seething chaos reigns, worse if anything than at any previous time. Not long ago, another ministerial statement was given out to the effect that after May 1 not a sound of a hammer would be heard in the show. The hammering in the Electricity Building has been terrific ever since that date, with no sign of early diminution. But the present fever and rush are welcomed by everybody as an evidence that the long period of preparation is at last nearing its close. It is to be expected that many exhibitors will still be dilatory in getting ready, but their goods will be in this week, and the freight cars will be out; while spaces not occupied are all being confiscated. This is so far as applies to the main exposition. It may be seriously doubted whether Vincennes will be ready for two or three months to come—if then.

WANT OF CURRENT continues to be the complaint of a good many exhibitors, and "concessionaires" on the Champ de Mars and around the Trocadero. A number of the generating units are now ready, but they are being very carefully tested out after so prolonged an exposure to dust and damp, both of which are still too prevalent for comfort. The fine Siemens-Halske unit in the German section was run on open circuit May 10, and its 2500 kilowatts of three-phase current will be very welcome to M. Picou, the electrical engineer-in-chief. The beautiful Lahmeyer unit of 1500 kilowatts was started up this week, when it was found that some malicious person had deftly slipped grit into the bearings, which warmed up at once to such an extent that trouble would have resulted if the machine had not been instantly stopped. An inquiry on the subject is being made by the police. It is said that only mechanics could have done this dastardly mischief.

THE MOVING SIDEWALK is a great hit. Not only did it start on time just when its services were needed, to help people get around the blocked grounds of the inchoate show in the opening week, but it furnishes endless talk and amusement daily. The first Sunday it carried 68,000 people, and every Sunday since has been about as good, while the average daily use in the week is said to run from 25,000 to 40,000. At 10 cents a head that is good business. The increase of load makes little difference in the current readings at the power house.

NATIONAL PAVILION. The American National Building on the Street of Nations opens with a Sousa flourish of trumpets on Saturday afternoon, May 12. At first, Commissioner Peck intended to issue addressed invitations, but the list grew and grew, every one of the 100,000 Americans now reported to be in Paris making a personal appeal for a card. The result is that a general invitation has been issued to all good Americans to come around during the afternoon and join in the crush. The lower lights will be burning in the shape of real cocktails at the American basement bar, and the higher lights will be going in the evening in the shape of the electric illuminations of the dome. There are electric elevators but they will not be available, the cars being still on the sea. The American section at Vincennes is to open early next week, with Sousa in the band wagon, his last appearance before he goes off traveling to add to the enormous success he has made in Paris.

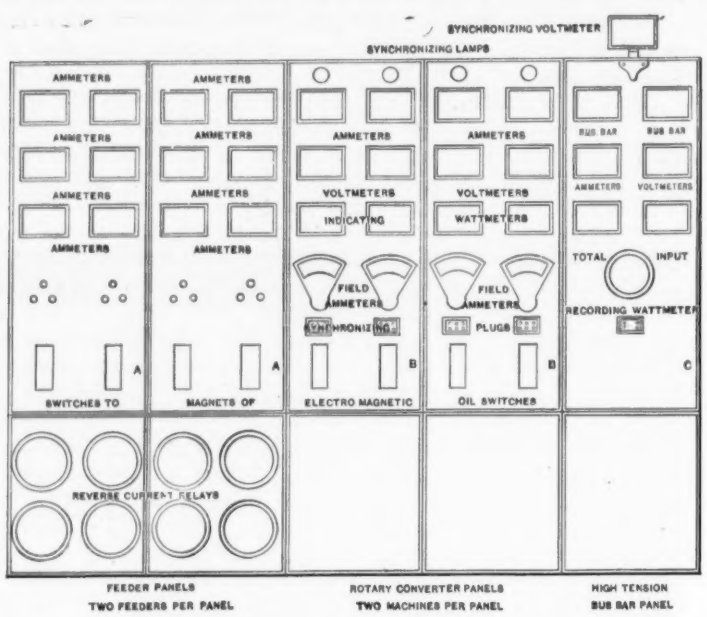
AN ARMOUR DINNER. There are a number of young graduates of the Armour Institute of Technology doing excellent work in the American electrical and mechanical sections, and on May 11 they gave a dinner to Director F. E. Drake and his assistant, Mr. J. S. Anthony, at La Perouse Restaurant, down on the studious Quai des Grand Augustins. The affair was organized by Mr. C. T. Malcolmson, chief engineer of the United States Department of Machinery and Electricity; and there were also present of the Armour men: Messrs. E. C. White, superintendent of the United States Machinery Hall at Vincennes; G. H. Patten, in charge of electrical work on the United States Pavilion; S. E. Bippus, assistant engineer, Vincennes; H. S. Powers, chief draughtsman Department of Exhibits; W. E. Weinsheimer, superintendent of Collective Exhibit of Electrical and Mechanical Goods, Champ de Mars; Maurice Lee, assistant engineer, Machinery and Electricity, Champ de Mars. The pretty menu was specially designed by Mr. Malcolmson, combining Armour and United States Commission "motifs," and the room decorations were in Armour colors—yellow and black, with the flags of the United States and France. It is almost needless to add that the speeches were reminiscent of the ordeals passed through in getting ready, and out of which the United States Commission has come so admirably, thanks in no small degree to the sturdy efforts of this earnest body of young men just out of college, for whose willing aid many an American exhibitor feels deeply grateful.

The Polyphase Distributing System of the Metropolitan Street Railway Company of New York City—VII.

BY J. E. WOODBRIDGE.

THE SUB-STATION HIGH-TENSION CIRCUITS.

Referring to the diagram of sub-station connections, Fig. 27, the arrangement of the feeder circuits at the incoming end will be apparent. As noted above, the oil circuit breaker through which each feeder reaches the sub-station high-tension bus-bars is operated by means of reverse-current relays termed in the drawing "reversal relays." It will be seen that the fields of these motor relays are supplied from current transformers, each of which has two secondary windings. These are termed in the drawing "double-current" transformers. One of these windings serves for the ammeter and the other for the reversal relay, there being three ammeters, one for each phase, at the incoming end of each feeder. By referring back to the diagram of connections of the power station it will be seen that only one ammeter is inserted in the feeder at that point, an induction wattmeter being also connected at that end of the feeder to integrate the kilowatt-hours transmitted per feeder. Inserted in the sub-station high-tension bus-bars between the incoming feeders and the outgoing connections to the step-down transformers are series transformers supplying instruments on the station panel which indicate the total incoming current per phase and integrate the total incoming



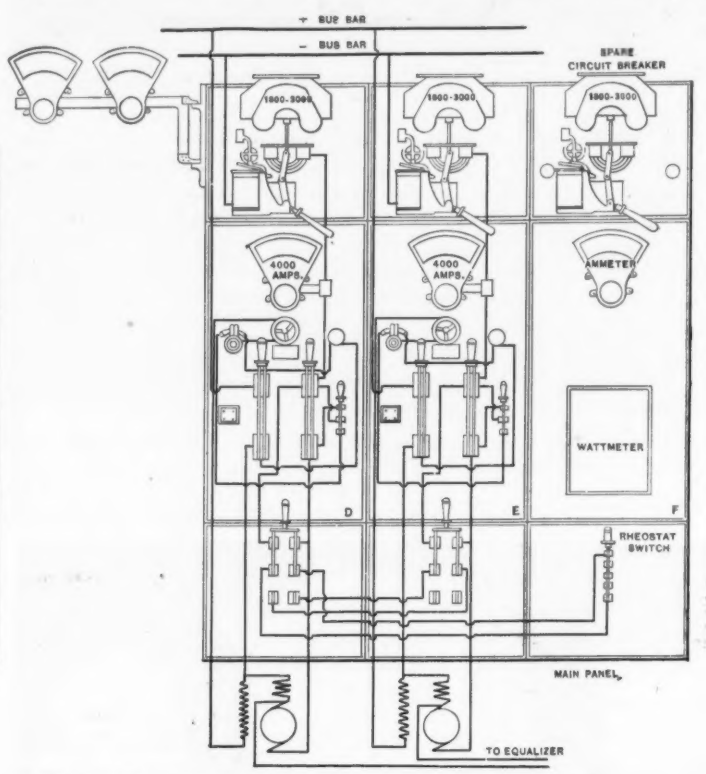


FIG. 26.—ALTERNATING-CURRENT SWITCHBOARD AND PART OF DIRECT-CURRENT SWITCHBOARD AT SUB-STATION.

kilowatt-hours of the sub-station. This gives figures for comparison with the readings of the instruments on the station panel of the direct-current switchboard, giving directly the all-day efficiency of the transformation and conversion carried on in the sub-station.

Each transformer-converter unit has a panel on the alternating-current switchboard with the instruments indicated in the elevation of the board, Fig. 26, the connections of which are shown in the sub-station diagram, Fig. 27. It will be noted that on this alternating-current panel is a direct-current ammeter connected in the field circuit of the rotary. This is provided to give a means of comparing the reading of the alternating-current ammeter and the alternating-current indicating wattmeter, taking into account the field current, so that the matter may be adjusted to give the power factor desired. The field ammeter also serves as an indication on the alternating-current board of what machines have their fields excited, and hence are presumably in operation, thus giving the switchboard attendant a positive indication on the alternating-current board of which panel he should step to, to close the oil circuit breaker when a rotary has been started up from the direct-current panel. The secondary circuits of the current transformers, as well as the frames of the ammeters used therewith, are grounded to prevent a shock being obtained from the instruments in case any current or static charge leaks through the insulation of the current transformers.

It will also be noted from the diagram that there are two oil circuit breakers in series with each other between the high-tension bus-bars and the primary windings of the step-down transformers. These are provided (as are the two circuit breakers between each of the two generators and the power station bus-bars) to give a reserve means of opening in case one switch fails to act, and to allow a trial of the circuit breakers before their use. The controlling switch of one of these circuit breakers has a differential magnet connected with overload relays, as described in the section on the oil circuit breakers, to throw the transformer-converter unit out of circuit in case it becomes heavily overloaded. This automatic controlling switch is mounted on the alternating-current panel of the corresponding transformer-converter unit. The controlling switch of the other oil circuit breaker of the same transformer-converter unit has no automatic features and is only operated by hand. It is mounted on the rotary panel of the direct-current switchboard. In starting a fresh rotary, the automatic controlling switch is closed before the machine is synchronized. The synchronizing is done at the direct-current panel by means of the field switch, and the machine is thrown into the alternating circuits by means of the hand controlling switch on the same panel. The automatic controlling switch on the other circuit breaker is thus free to open in case the conditions are not right, and is not restrained by the operator's hand.

The synchronizing receptacles are so wired that the machines can be synchronized with each other or with the alternating-current bus-bars.

THE SIX-PHASE CONNECTIONS.

The step-down transformers are unique in that they deliver six phases to the rotary converters. This is the first case in which six-phase rotaries have been commercially used in this country, and probably the first case in the world. The purpose of this unusual number of phases is to reduce the copper losses in the rotary armatures and consequently raise the capacity of the rotaries with the same temperature rise. As rotary converters have no field distortion their capacity is determined solely by their heating limit and their commutating ability, so that any means of reducing the heating correspondingly increases the number of kilowatts which a given machine will convert, provided there is sufficient field strength to reverse the currents in the armature coils as their commutator segments pass under the brushes. It has been shown in these columns* that (to assume a simple case) a machine which will deliver 100 kilowatts without overheating when driven mechanically as a generator, will deliver 131 kilowatts with the same tempera-

*Steinmetz, *The Electrical World*, Dec. 17, 1898.

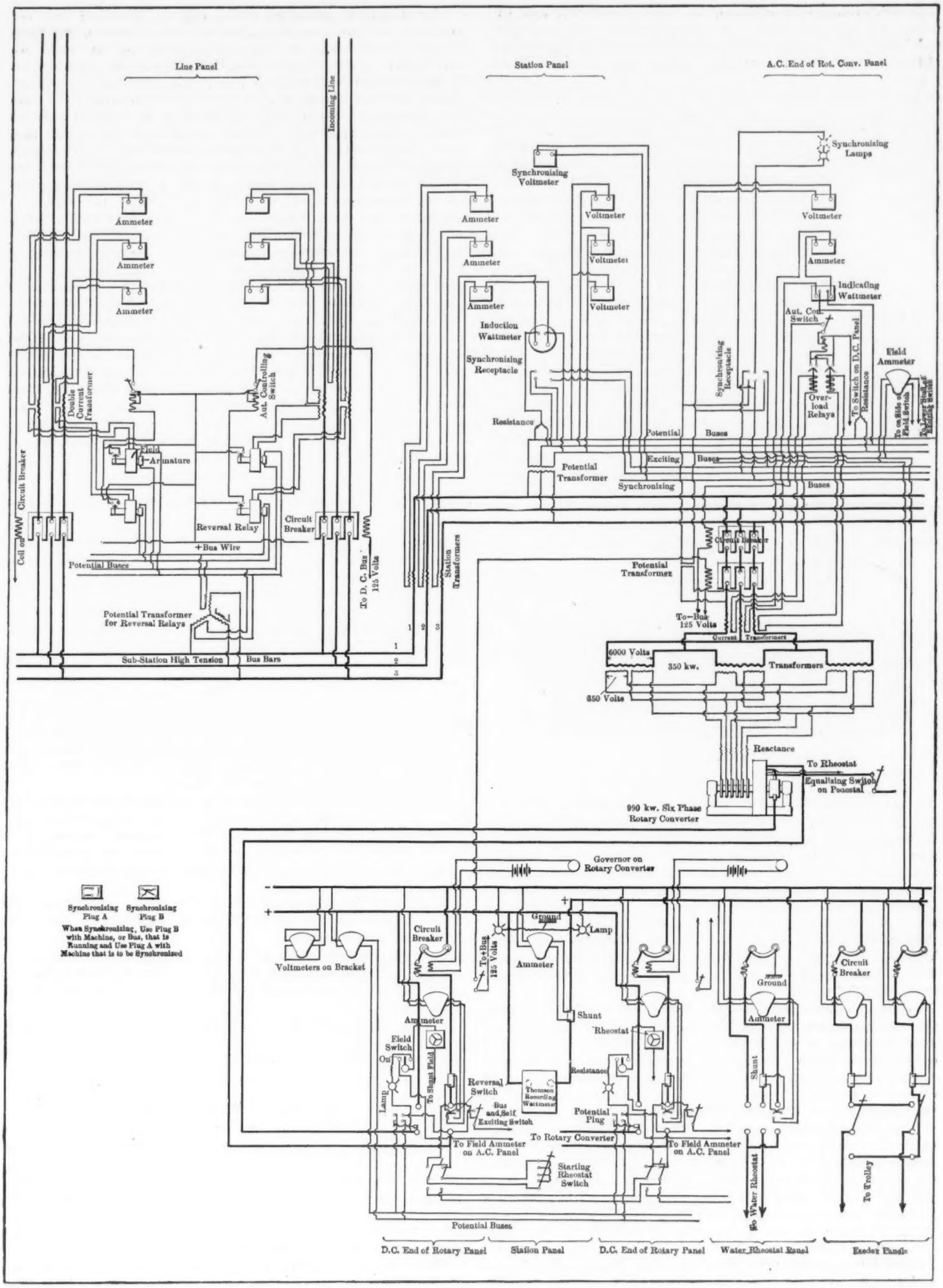


FIG. 27.—A DIAGRAM OF THE CIRCUITS OF A TYPICAL SUB-STATION.

ture rise when run as a three-phase rotary converter, and will deliver 194 kilowatts when run as a six-phase rotary converter, other conditions remaining the same. This is allowing for the internal losses of the converter and assuming that the impressed e. m. f. is in phase with the counter e. m. f. of the machine. If wattless currents are not carefully balanced out or are used for purposes of regulation the output of the machine with either number of phases falls off somewhat, but the six phases still show about the same advantage over the three phases. Assuming that a wattless component amounting to 30 per cent of the total alternating-current input of the machine is drawn in, the same 100-kw generator would deliver 122 kilowatts as a three-phase rotary and 167 as a six-phase rotary. In addition to the reduction of the heating, the six-phase arrangement distributes the heating much more uniformly around the armature of the rotary than do three phases, with which the heating is rather badly concentrated in a few coils.

While the term "six-phase" conveys at first thought an idea of considerable complexity, it really requires but very little modification of the usual three-phase arrangement. The generators and high-tension transmission lines are three-phase, the six phases being derived from three in the step-down transformers, which are of the usual single-phase type, and three in number, but have each two electrically-independent secondaries. These six secondaries of the step-down transformers are connected up in two separate deltas. An idea of how this gives six phases suitable for rotary converter work can be gained from the vector diagram, Fig. 28. The circle represents the distributed elementary e. m. fs. in a direct-current armature under two poles. If this armature is to be made that of a three-phase rotary converter it is tapped at points 1, 2 and 3, and the three secondaries of the step-down transformers are delta connected across these points as represented by the lines 1-2, 2-3, and 3-1. If now points 4, 5 and 6 are tapped out to three more collector rings it will be readily seen that,

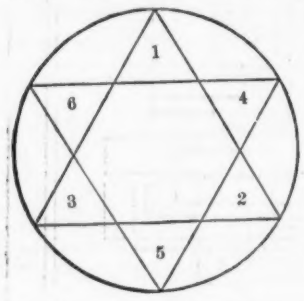


FIG. 28.—CONNECTIONS OF DOUBLE DELTA TO GIVE SIX PHASES.

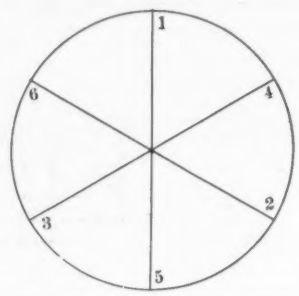


FIG. 29.—CONNECTIONS OF DOUBLE Y TO GIVE SIX PHASES.

when the machine rotates, the alternating e. m. f. set up between 4 and 5, for example, is exactly one-half a period behind that between points 3 and 1; correspondingly the alternating e. m. f. between points 5 and 6 is exactly 180° displaced in phase from that between points 1 and 2, and that between 6 and 4 bears the same relation to that between 2 and 3. Two alternating e. m. fs. exactly opposite to or 180° out of phase with each other can be derived from one transformer by means of two secondaries with the connections of one reversed from those of the other. This is the means adopted in this installation. Windings 6-4 and 3-2 are electrically independent secondaries in one transformer, 3-1 and 5-4 are in another transformer and 1-2 and 6-5 are in the third transformer.

Thus all that is required for a six-phase rotary installation as compared with a three-phase rotary installation is six collector rings per rotary (instead of three) tapped to six points (instead of three) per pair of poles in the armature winding, two electrically separate secondaries (instead of one) in each of the three step-down transformers and six conductors (instead of three) from the step-down transformers to the rotary collector rings, these six conductors having one-half the cross-section of the original three. There being no switches, fuses or instruments between the transformers and the rotaries the increased complexity of the circuits is slight. The connections between the six secondaries of the three transformers so as to give two deltas 180° displaced in phase from each other instead of two deltas in phase with each other—and thus to give six phases instead of three—are shown in the diagram of connections of the sub-station, Fig. 27.

It is obvious that six phases could be obtained from three transformers by connecting them up as shown in Fig. 29. In this case each transformer would have one continuous secondary winding connected to the armature conductors of the rotary at points 180 electrical degrees apart. The circuits would be a trifle simpler with this arrangement, each transformer having only two secondary leads instead of four, there being no necessity of cross-connecting the three transformer secondaries at their common crossing. This double Y, as it might be called, involves a difficulty in starting the rotaries from the direct-current end, when, as in this case, there are no switches between the transformers and the converters. This difficulty is that if two collector ring taps came directly under the brushes when at standstill the transformer secondary would be in shunt with and practically a short circuit across the armature winding. Owing to the low resistance of the transformer winding it would absorb a large part of the starting current sent in, requiring just that much more current to overcome the friction of rest of the rotary armature. As soon as the machine is in operation the armature begins to turn, the voltage impressed upon the transformer windings becomes alternating and the objection no longer applies, but before starting there is no assistance from this source. It is interesting to note that this same objection applies to two-phase rotary converters connected and started in this way.

This difficulty could be overcome with a double Y by dividing the secondary of each transformer into two sections and connecting these up in two independent Ys, one connected to points 1-2-3 and the other to points 4-5-6, the two central points of the two Ys being insulated from each other. A double delta is, however, preferable to the double Y for the same reason that with three phases a single delta is preferable to a single Y, viz., the freedom it and the delta connection of the primaries allow to work with two transformers if one becomes crippled.

Report of Institute Committee on Units and Standards.

At the Philadelphia meeting of the American Institute of Electrical Engineers, the Committee on Units and Standards reported that it had considered the following resolution, passed at the regular meeting of the Institute on the 28th of March, 1900:

Resolved, That the Committee on Units and Standards be requested to investigate and report at the ensuing meeting in regard to the advisability of the following:

1. The giving of names to the Absolute Units of the Electrostatic and Electromagnetic systems. 2. The denotation by means of prefixes of multiples of such units. 3. The rationalization of the present system, by means of taking the absolute unit of magnetism as equal to the present magnetic line, and the absolute difference of magnetic potential as equal to the present absolute unit of current-turn. 4. The advisability of taking up any or all of the above matters at the congress to be held in Paris this year.

The report of the committee on these propositions was as follows:

1. We consider that there is need for names for the absolute c. g. s. units in the Electrostatic and the Electromagnetic systems; also for suitable prefixes to denote decimal multiples and submultiples of these units, in supplement and addition to those already in common use.

2. That the International Electrical Congress convening this year at Paris should be urged to bestow the above-mentioned names and create said decimal prefixes.

3. That much advantage would accrue to a universal "rationalization" of electric and magnetic units, and that the congress be requested to consider the means and advisability of such "rationalization."

4. That we recommend that the whole subject should be brought up as a topic for general discussion at the approaching general meeting of the Institute in Philadelphia.

Automobile Week at Nice.

For five days during the latter part of March, from the 25th to 30th inclusive, Nice was the centre of automobile interest in France. The fêtes, under the auspices of the Automobile-Velo Club de Nice, included an exhibition of automobiles, a series of races from one mile (1609 metres) to 410 kilometres in length, several parades and a "Battle of Flowers." The parade illustrated the facility with which automobiles lend themselves to flower ornamentation. The vehicles themselves, mostly of the explosion-engine type, were generally of much heavier construction and more cumbersome in appearance, than the present-day American machines, and quite noisy in operation.

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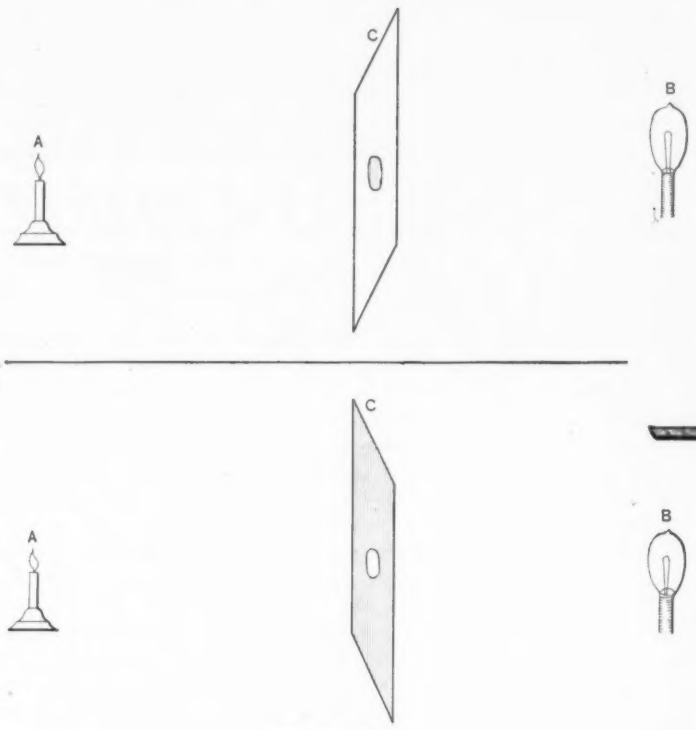
Elements of Illumination—III.

By Dr. Louis Bell.

WITH respect to the best direction of illumination only very general suggestions can be given. Brilliant light, direct or reflected, should be kept out of the eye and upon the objects to be illuminated. In each individual case the nature and requirements of the work must determine the direction of lighting.

The old rule, given for reading and writing that the light should come obliquely over the left shoulder well illustrates ordinary requirements. By directing the light from the point indicated direct light is kept out of the eyes, and any light regularly reflected is also kept out of the way. The eye catches then only diffused light from the paper before it, and if the light comes from the left (for a right-handed person) the shadow of hand and arm does not interfere with vision. If work requiring both hands is under way the chances are that the best illumination will be obtained by directing it downwards and slightly from the front, in which case care must be exercised to avoid strong direct reflection into the eyes. The best simple rule is, avoid glare direct or reflected, and get strong diffused light from the object illuminated.

This brings us at once to the very important but ill-defined question of the strength of illumination required for various kinds of work.



FIGS. 1 AND 2.

Fortunately, the eye works well over a wide range of brightness, but there is a certain minimum illumination which should be exceeded if one is to work easily and without undue strain. The matter is much complicated by questions of texture and color, which will be taken up presently, so that only general average results can be considered. For reading and writing experience has shown that an intensity of about *one candle-foot* is a suitable amount with ordinary type and ink, such as is here used, for instance. With large, clear type

like that used for this particular line

half a candle foot enables one to read rather easily, while in ordinary type set solid or in type of the smaller sizes,

such type as is employed in this line as a horrible example

two candle feet is by no means an unnecessary amount of lighting. Dense black ink and clear white paper not highly calendered, such as some of the early printers knew well how to use, makes vastly easier reading than the grayish-white stuff and cheap, muddy-looking ink to be found in the average newspaper.

Illumination less than half a candle-foot usually renders reading somewhat difficult and slow, the more difficult and slower as the illumination is further reduced.

At one or two-tenths of a candle-foot, reading is by no means easy, and there is a strong tendency to get the book near the eye, thereby straining one's power of accommodation, and to concentrate the attention upon single words, a tendency which increases as the light is still further lessened.

In fact, when the illumination falls to the vicinity of one-tenth candle-foot it is of very little use for practical purposes of reading or working.

One may get a fair idea of the strength of illumination required for various purposes by a consideration of that actually furnished by nature. To get at the facts in the case, we must make a little digression in the direction of photometry, a subject which will be more fully discussed later.

To get an approximate measure of the illumination furnished by daylight, one can conveniently use what is known as a daylight photometer. This instrument furnishes a means for balancing the illumination due to any source against that due to a standard candle at a known distance. Like most common forms of photometer it consists of a screen illuminated on its two sides by the two sources of light respectively. Equality of illumination is determined by the disappearance of a grease spot upon the screen. A spot of grease on white paper produces, as is well known, a highly translucent spot which looks bright if illuminated from behind, and dark when illuminated from the front.

Thus, if one sets up such a screen *C* between and equidistant from a candle *A* and an incandescent lamp *B* and then looks at the screen obliquely from the same side as *B*, the appearance is that shown in Fig. 1. Getting around on the other side of the screen one gets the effect shown in Fig. 2. By moving the candle *A* nearer or the incandescent *B* farther off, a point will be found where the spot becomes nearly invisible on account of the equal illumination on the two sides. This "Bunsen photometer screen" requires very careful working to get highly accurate results, but gives closely approximate figures readily. The daylight photometer, Fig. 3, is the simplest

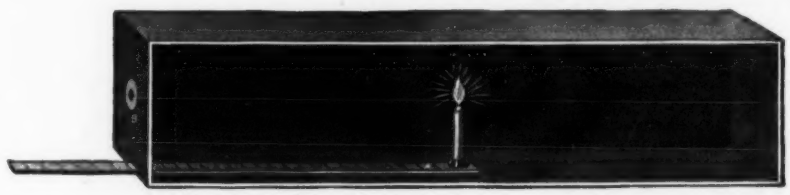


FIG. 3.

sort of adaptation of this principle. It consists of a box say, five or six feet long and fifteen inches square. In one end is a hole *B* filled with the photometer screen just described, and a slot to receive a graduated scale *A* carrying a socket for a standard candle. The interior of the box is painted dead black, so as to avoid increasing the illumination at *B* by light reflected within the box.

Setting up the box with the end *B* pointing in the direction of the illumination to be estimated, the candle is slid back and forth until the grease spot disappears, when the distance from the candle to *B* gives the required illumination, by applying the law of inverse squares, which holds sufficiently well for the purpose if the box is well blackened.

Of course the results of such measurements vary enormously with different conditions of daylight. Three measurements made in a large, low room with windows on two sides, culled from the writer's note book, give the following results, the day being bright, but not sunny, and the time early in the afternoon:

Facing south window	6	candle-feet.
Facing east window	2.2	" "
Facing north wall	0.7	" "
And again, 10 feet from south window, on a misty April day, 5 p. m.	0.5	" "

On a clear day the diffused illumination near a window, while the sun is still high, will generally range from 5 to 10 candle-feet, while in cases where there are exceptional conditions for brilliant illumination it may rise to twice or even four times the figures just given.

Now, these figures for the lighting effects of diffused daylight give a good clue, if nothing more, to the intensity of illumination required for various purposes. In point of fact, reading and writing require less light than almost any other processes which demand close ocular attention. Everything is black and white, there is no delicate shading of colors nor any degrees of relief to be perceived

in virtue of differences in light and shade. Moreover, the characters are sharply defined and not far from the eye. It is therefore safe to say that for any work requiring steady use of the eyes at least one candle-foot is demanded. If practicable, this minimum should be doubled for really good lighting and for work on colored materials, or with much fine detail not less than five candle-feet should be provided. Even this amount should be doubled for the finest mechanical work, such as engraving, watch repairing and similar delicate operations. In fact, for such cases the more light the better, provided the source of light and direct undiffused reflections therefrom are kept out of the eyes.

These estimates have taken no account of the effect of color, which sometimes is a most important factor, alike in determinating the amount of illumination necessary and in prescribing the character and arrangement of the sources of light to be employed.

The relation of color to practical illumination is somewhat intricate, for it involves considerations physical, physiological and æsthetic, but it is well worth studying, for while in some departments of illumination, such as street lighting, it is of little consequence, in lighting interiors it plays a very important part. In lighting a shop where colored fabrics are displayed, for example, it is desirable to reproduce as nearly as may be, the color values of diffused daylight, even at considerable trouble. Such illumination, however, may be highly undesirable in lighting a ball-room, where the softer tones of a light richer in yellow and orange would generally be far preferable.

In certain sorts of scenic illumination distinctly colored lights must be employed, but always with due understanding of their effect on neighboring colored objects. Sometimes, too, the natural color of a light needs to be slightly modified by the presence of slightly tinted shades, serving to modify both the intrinsic brilliancy and the color.

The fundamental law with respect to color is as follows: ***Every opaque object assumes a hue due to the sum of the colors which it reflects.*** A red book, for instance, looks red because from white light it selects mainly the red for reflection while strongly absorbing the green and blue.

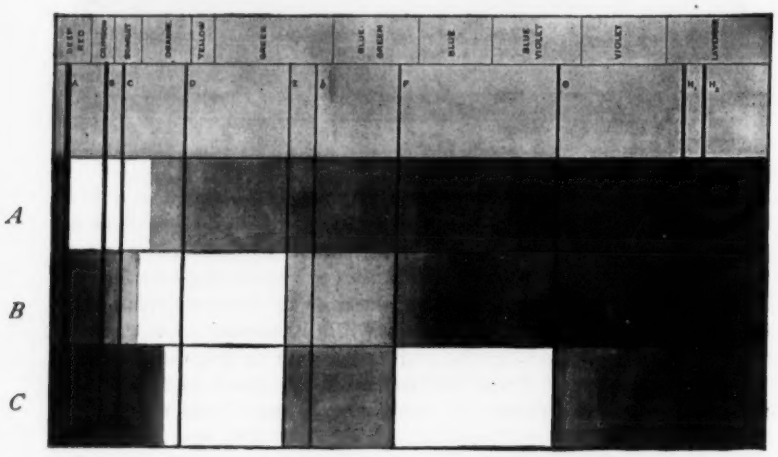


FIG. 4.

White light, as a look through a prism plainly shows, is a composite of many colors, fundamentally red, green and blue, incidentally of an almost infinite variety of transition tints. If a narrow beam of sunlight passes through a prism it is drawn out into a many-colored *spectrum* in which the three colors mentioned are the most prominent. Closer inspection detects a rather noticeable orange region passing from red to green by way of a narrow space of pure yellow, which is never very conspicuous. The green likewise shades into pure blue through a belt of greenish blue, and the blue in turn shades off into a deep violet. If the slit which admits the sunlight is made very narrow, certain black lines appear crossing the spectrum—the Frauenhofer lines due to the absorption of various substances in the solar atmosphere. These lines are for the purpose in hand merely convenient landmarks to which various colors may be referred. The several lines were designated by Frauenhofer by the letters of the alphabet, beginning at the red end of the spectrum.

Fig. 4 shows in diagram the solar spectrum with these lines and the general distribution of the colors. A scale is subjoined merely for the purpose of future reference. The *A* line, really a broad dark band of many lines, is barely visible save in the most intense light and the eye can detect little or nothing beyond it. At the other end of the spectrum the *H* lines are in a violet merging into lavender, are not easy to see, and there is but a narrow region visible beyond them—pale lavender, as ordinarily seen. The spectrum, as engraved in the accompanying illustration (Fig. 4), is roughly mapped out to show the extent of the various colors as distributed in the ordinary prismatic spectrum.

At *A* Fig. 4 is shown the spectrum of the light reflected from a bright red book, i. e., the color spectrum which defines that particular

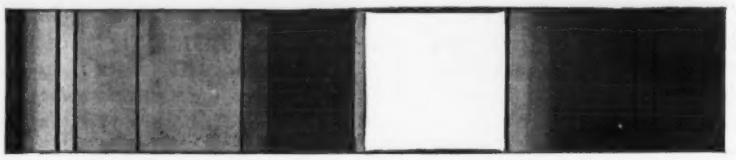


FIG. 5.

red. It extends from a deep red into clear orange, while the absorption, which is indicated in yellow and yellowish green is by no means complete.

At *B* Fig. 4 is the color spectrum from a green book. Here there is considerable orange and yellow, a little red and much bright green, together with indications of a rather weak absorption in the bluish green.

C shows a similar diagram from a book apparently of a clear, full blue. The spectrum shows pretty complete absorption in the red and extending well into the orange. The orange-yellow and yellowish green remain, however, as does all the deep blue, while there is a perceptible absorption of the green and bluish green.

Now, these reflective spectra are thoroughly typical of those obtained from any dyed or painted surfaces. The colors obtained from pigments are *never* the simple hues which they appear to be, but mixtures more or less complex, sometimes of colors from very different regions of the spectrum. Most of the commoner pigments produce absorption over rather wide regions of the spectrum, but some of the delicate tints found in dyed fabrics show several brands of absorption in quite different portions of the spectrum. These are the colors most seriously affected by variations in the color of the illuminant when viewed by artificial light. Fig. 5 is a case in point, a color spectrum taken from a fabric which in daylight was a delicate corn-flower blue. The absorption begins in the crimson, leaving much of the red intact, is partial in the orange and yellow, stronger in the green and quite complete in the bluish-green region. The blue well up to the violet is freely reflected, and then the violet end of the spectrum is considerably absorbed. Most of the reflected light is blue, but if the illumination is conspicuously lacking in blue rays, as is the case with candle light or common gas light, the blue light reflected is necessarily weak, while the red contingent comes out at its full strength and the visible color of the fabric is distinctly reddish.

A similar condition is met in certain blues which in daylight reflect a large proportion of blue and bluish violet, but in which some green rays are left, just as was the clear red in Fig. 5. By gas light the blue is relatively very much weakened and the apparent color is unmistakably green. Such changes in hue are in greater or less degree very common and furnish some very curious effects. Sometimes a color clear by daylight appears dull and muddy by artificial light, and in general the quality of the illumination requires careful attention whenever one deals with delicate colors.

The absorption found in the pigments used in painting is seldom so erratic as that shown in Fig. 5, but pictures often show very imperfectly under ordinary artificial illumination.

It is no easy matter to get a clear idea of the color properties of various illuminants. Of course, one can form spectra from each of the lights to be compared, and compare the relative strengths of the red, blue, green and other rays in each, but this gives but an imperfect idea of the relative color effects produced, for the results themselves are rather discordant, and the relative brightness thus measured does not correspond accurately with the visual effect. Probably a better plan from the standpoint of illumination is to match the visible color of a given illuminant accurately by mixtures of the three primary spectral colors, red, blue-violet and green, and determine the exact proportions of each constituent required to give a match. Even this evidently does not tell the whole story, but it gives

an excellent idea of the color differences found in various lights. Such work has been very beautifully carried out by Abney, from whose results the following table is taken:

	Sunlight	Skylight	Arclight	Gaslight
Red.....	100	100	100	100
Green	193	256	203	95
Violet.....	228	760	250	27

Incandescent lamps are not here included, but give enormously different results according to the degree of incandescence to which they are carried. If burned below candle-power they give a light not differing widely from gas light, while if pushed far above candle-power the light is far richer in violet rays and becomes nearly white. Unfortunately, however, it does not reach this point save at a temperature that very quickly ends its life.

The Properties of Carbon in Electrical Work—II.

BY ELIHU THOMSON.

(Concluded.)

Many attempts have been made to substitute other materials for carbon in incandescent lamps, it being well recognized that if a substance could be found which would stand as well as carbon, while allowing a considerable elevation of working temperature, a great gain in the efficiency would result. Thus far all such attempts have failed.

Attempts have also been made by many people to incorporate other substances with the carbon filament or to coat it with what are sometimes called luminescent substances, supposed to be capable of converting comparatively low temperature heat into light, or rather of giving out light at relatively low temperatures. I refer to the use of oxides of thorium, zirconium and cerium, as used in the Auer Von Welsbach mantle, or calcium oxide as used in the lime light. Personally, I could anticipate only failure in these cases on account of the inevitable disintegration of the mixed filament, and the doubt I have long had as to the cause of the luminescence in question. Experiments made a number of years ago tended to show that the light emission from mantle material was really a result of high temperature, and that the substances called luminescent have the power, like platinum sponge, of causing union of flame gases with oxygen in their pores when heated.

I may mention another attempt, since it has recently been revived with something of a flourish of trumpets in England. Several years ago a German named Dr. Langhans claimed to have made the discovery that the introduction of silicium in proper proportion would greatly improve carbon filaments. Such testimony was forthcoming that Dr. Langhans was set to work at Lynn to develop his invention. We then began making discoveries ourselves. Dr. Langhans depended for his silicium upon the amorphous brown powder on the market under that name, which our chemist soon determined to be a lower oxide, SiO, and not silicium at all. The element itself was not to be had and we had to make it. It was finally obtained by several methods, but always in beautiful blue-black crystals, or as coherent masses.

This was ground to impalpable powder in an agate mill and mixed with viscous cellulose before the mass was squirted into filaments. It was noted that upon heating the filaments in vacuo to an increasing incandescence, a sudden great increase of resistance took place which Dr. Langhans claimed to indicate chemical union of the carbon and silicium, but which I suspected to be due to the loss of the silicium by evaporation. I had noticed that the glass vessel in which the operation was performed was gradually acquiring a brown coating. Our chemist, under my instructions, then coated carbon filaments with silicium by heating them in silicium hydride. We then found that the coatings could be melted so as to drip along the outside of the filaments and raising the heat volatilization took place with the formation of brilliantly colored silicium coatings on the glass of the enclosing bulb. Similar experiments with boron coatings gave like deposits of a steel gray color. Dr. Langhans quite failed to make good his claims, but appears to have lately revived the supposedly defunct carbo-silicium filament. Our only result was a far better knowledge of silicium and boron and some fine specimens of these elements.

Even in regard to telephony carbon holds a special place and no efficient substitute has been found for it. I refer to the carbon transmitter in its various forms, utilizing the property of variation of contact resistance under variations of pressure.

In this case as before, both the physical and chemical properties of carbon conduce to its usefulness. The contact possesses the quality of permanence in a high degree. The carbon does not oxidize at low temperatures, and if it does so at a high temperature by the heating of the contact, gases are produced which escape and leave the contacts still unhampered and unclogged. With most conductors, oxidization, when it occurs, soon reduces the contact conductivity. Even with such metals as platinum the effect of sparks at contacts is to produce a non-conducting coating of the fine metal or platinum black, which soon stops the current. Then again the density of the non-oxidizable metals is too high for free movement to be communicated by voice waves, and filings or granules soon pack together badly. The low density of carbon is therefore a valuable property. Most metals also conduct much too freely, while carbon is a resisting conductor, occupying a place between good conductors and insulators. Moreover, its conductivity is adjustable within wide limits according to its density and the manner of formation. A current passed through imperfect contacts of metal particles is apt to cause them to cohere to some degree, an effect absent with carbon granules. They do not weld electrically, being too infusible for that.

The conductivity of carbon rises with increase of temperature up to a limit beyond the temperature of incandescence of a carbon filament. The cold filament may have double the resistance that it has when hot. Metals, on the contrary, fall in conductivity with increased temperature. A few alloys change but slightly, but only through a limited temperature range, decreasing outside of this range. I am led to think that the property of carbon, of gaining conductivity with increased temperature, may be one of the chief causes of its standing so much alone as a material for a telephone transmitter. So far as I know, attention has not hitherto been directed to the possible value of the property under consideration, though it was called to my mind a number of years ago. Any two carbon granules in a telephone transmitter may be considered as being quickly pressed together and then separated by the effect of voice waves. The surface of contact, owing to the yielding of the porous carbon, increases under pressure and diminishes under relief of pressure. When the contact is improved more current flows, and vice versa. But the energy given out increases as the square of the current and diminishes only directly as the fall in resistance. Hence, in any case of improvement of contact by pressure more heat energy is given out at the contact in this case. The heat is purely local to the contact surfaces, as the carbon is a poor conductor of heat. But hot carbon conducts better than cold, and this again improves the contact. The effect is therefore, within certain limits, cumulative. The moment the carbon granules begin to be separated the effects are reversed and the action is again cumulative in stopping the flow of current, thus greatly intensifying the effect initiated by the voice wave. The variations of current upon which the transmission depends are given a greater amplitude than could possibly have been the case with other known conducting materials having in other regards suitable properties. The numerous granules beat about in the transmitter and are constantly exposing new surfaces, which fact alone prevents the contacts from attaining an average temperature. Unless some material can be found having in a greater degree the desirable qualities above pointed out, carbon must continue to be the only material for telephone transmitters. In each case of the peculiar adaptability of carbon, here dwelt upon, it is not any single property which is the controlling factor, but a concurrence of several properties in the same substance.

It is curious to note that here as in the case of the incandescent lamp, carbon was not the first choice of material for a variable resistance transmitter. A wire dipping into a conducting liquid was originally proposed by Dr. Gray in his famous caveat. This was before Edison invented his carbon telephone or Hughes the carbon microphone. The Berliner patent of which we have heard so much describes a contact transmitter using metal balls.

There is one other striking example of the peculiar adaptability of carbon to electrical uses which I desire to briefly mention. In this case as in the others no adaquate substitute for it exists. I refer to the use of hard carbon as a commutator contact or brush.

Brushes of springy metal wire or sheet had been for years in use on the commutators of electric motors and dynamos, before the street-railway motor began to be developed. The conditions of service under a car were so varied, so harsh and severe as compared with former work with electric machinery, that the commutators and brushes together were quickly destroyed, though constituting a very expensive part of the machine. Burn-outs and interruptions to service were all too common and largely arose from this cause. The metal brushes which had in former practice served fairly well under favorable conditions and which had been tolerated under unfavorable conditions, were found to be decidedly intolerable. They were made in all conceivable ways conducive to their successful use in the hard service, but without avail. The industry was likely to be checked or become ruinous. Repairs were so frequent and expensive that unless a satisfactory substitute for metal brushes could be found it was felt that it would become necessary to call a halt in the extension of electrical railway work by the company with which I was working. At this critical juncture the late Mr. Van De Poele, who was one of our corps of engineers, suggested a trial of his carbon brush invention. The success was so immediate and striking that a great burden was, as it were, suddenly lifted from our shoulders and the carbon brush at once became universal in railway motor work. Its use gradually spread to the generators in the power stations and to other machines, so that it is now a rare thing to find a dynamo or motor operating with metal brushes, except arc machines and very low potential machines, such as are used for plating.

Here again, as in the case of the incandescent lamp and the telephone transmitter, carbon was the later choice, but its adaptability was found to be so special that nothing has been found which can act as a substitute, even though ten years have elapsed since its introduction.

It would require too long and too technical a discussion to detail the exact reasons for the condition just pointed out. The lack of any tendency to fuse, stick or weld to the metal commutator segments, and the absence of solid oxides to clog the contact are undoubted factors of great value in this case. The carbon block used as a brush does not cut the metal seriously and undergoes but little wear itself, though it is exceedingly cheap to replace. It makes an excellent running contact and allows rotation in either direction with equal facility, a condition almost impossible to attain with metal brushes. The chief property of carbon which is useful in this connection is its relatively low conductivity, from which results a freedom from excessive current, or short circuits and burning when the brushes do not happen to be in the best position of adjustment. Thus a great latitude is permitted, so great, indeed, that the actual design and construction of railway motors and like machinery, as a matter of economical engineering, has been much simplified in recent years. I have had in use on the dynamo of my private house lighting plant a modified carbon brush which has given remarkably good results after various forms of metal brush and even ordinary carbon brushes had been found unsatisfactory. The wear and tear with metal brushes and the frequent burnings were a great nuisance. The potential is 110 volts and the present brushes have fed forward about ⅛ inch in three and one-half years of use, about 7000 hours. The commutator is still in excellent condition, never having been turned, sand-papered or attended in any way whatever. The brushes are never adjusted after once being set. The commutator and brushes run quite cool. There is apparently no wear of the copper or so little as to be negligible. There is no grooving, though the commutator during the period above mentioned must have made about 500,000,000 of revolutions. The brushes are never shifted and the shaft does not play endwise. There is every indication that the brushes themselves might last fifty years, and the commutator indefinitely long.

The brushes are each composed of a bundle of carbon rods ⅛ inch in diameter and about 5 inches long. These were separately plated with copper all over, soldered together as a rectangular bundle and then given an outside copper coating, rather heavy. They are held in the brush holders which formerly carried the metal brushes and bear on the commutator in like manner. In this form of brush the resistance of the carbon brush except at its contact with the copper segments is practically eliminated, and this probably accounts for the fact that the finger can be held upon the tip of the brush during a run without detecting more than a very moderate warmth. It is certain that no other than a carbon contact could possibly give these results, and here again the position of carbon is unique.

The foregoing is the substance of a paper read at the Febru- meeting of the Northeastern Section of the American Chemical Society in Boston.

The General Meeting of the American Institute of Electrical Engineers.

IN this country but few opportunities are offered for those engaged in engineering work to meet and become acquainted with one another, appreciate the personal qualities of collaborators whose engineering attainments they know well, and discuss face to face the rapid advancement of their art. One of these opportunities is the annual general meeting of the American Institute of Electrical Engineers, an opportunity not as yet appreciated to the extent it deserves or the attendance would undoubtedly be greater. The success, both scientifically and socially, of such meetings as that recently held in Philadelphia must certainly tend toward a greater appreciation of this opportunity, and in consequence a more general enjoyment of it.

Of the two notable features of the meeting the first was the similarity of the problems attacked in three papers which were all presented on one day. These three papers treated respectively three different branches of electrical engineering, one, long-distance transmission of power; another, submarine telegraphy, and the third, long-distance telephony. The fact that the apparently widely different conditions of these three widely-different branches of electrical engineering are found to be special cases of the same general problem is significant of the development of engineering to such a point that fundamental conceptions are being reached rather than incomplete ideas. The other notable feature of the meeting was the series of enjoyable diversions and social entertainments provided by the Philadelphia Entertainment Committee, aided by local subscriptions for the purpose, the whole being most admirably engineered by Mr. Charles A. Bragg, at the head of the committee. The most valuable part of the discussion of practically all of the papers was, as usual, contributed by Mr. Charles P. Steinmetz.

The last previous general meeting of the American Institute in Philadelphia six years ago, has frequently been referred to as the most pleasant of all institute meetings socially. The hospitality extended to the institute during this meeting and the pleasant features of the entertainments provided, have amply justified the return to that city. On Wednesday evening many of the members present attended a Franklin Institute lecture by the noted Swiss scientist, Raoul Pictet on liquid air, illustrated by experiments. Following the lecture they visited the quarters of the Manufacturers' Club, to which they had been invited to attend a smoker. A pleasant entertainment with many amusing incidents was provided.

On the following afternoon practically all present were taken by steamer to Cramp's shipyard, where they inspected the new Russian cruiser, the *Variag,* now approaching completion, as well as the hull of the new American battleship to be named the *Maine.* In addition to many other craft with which the yard is now crowded there were other objects of interest, such as the mammoth hoists for the Calumet and Hecla mines which are being built at the same place. After leaving the yard the two boats chartered for the excursion proceeded down the river past the League Island Navy Yard, at which are lying the cruiser *Columbia,* a monitor, and the auxiliary cruiser, *Yankee,* well known to electrical engineers by reason of the service of some of them upon her during the late war.

From the navy yard the boats proceeded to Washington Park, where a shad dinner was served, the occasion being a most enjoyable one on all accounts and particularly by reason of the after-dinner speeches. Dr. Kennelly, the retiring president, called attention to the readiness of electrical engineers to come forward and sacrifice their labor and their own interests for the benefit of their profession. Secretary Pope recalled the suggestion of Mr. Steinmetz at the shad dinner of the last Philadelphia meeting that the jelly fish be crossed with the shad to make a boneless species of the latter. Washington Park being on the east side of the river Mr. Pope called attention to the fact that while the institute goes to Philadelphia for its presidents it goes to New Jersey for its shad dinners and secretaries.

Mr. P. N. Nunn gave an interesting and at times amusing account of his experiences with long-distance transmission in the West.

Mr. Gano S. Dunn spoke of the opportunities given by such meetings to become acquainted with other workers and competitors in the same field. Mr. Steinmetz made a humorous speech calling attention to the relief which the members must have felt when they found that he had no paper on the programme, and threatened to present one at the dinner on "A Method of Complexing Complex Quantities." Short addresses were also made by Messrs. Oberlin Smith, P. B. Delany and C. O. Mailloux. Mr. Charles A. Bragg served most admirably as toastmaster, his remarks adding greatly to the good fellowship of the occasion.

The annual business meeting was held at the rooms of the American Institute in New York City on the evening of Tuesday, May 15. At this meeting a paper somewhat out of the ordinary run of institute papers, in that it was written by a member of the bar, was presented. It was, however, of no less interest to engineers, since it discussed their relations to the legal profession in their work as electrical engineering experts. The paper gives those engineers who undertake expert work a chance to "see themselves as others see them."

The paper points out the derision which has recently been directed to expert evidence in some lines, and makes suggestions as to avoiding the danger of engineering expert evidence falling into similar contempt. In electrical matters particularly the lawyers and the courts are completely at the mercy of the experts, as none but the latter can hope to comprehend thoroughly the complicated points often involved. On this account the services of the expert are very important, and the expert should be correspondingly competent. The paper discussed the advantage of having an expert permanently connected with those courts which handle many engineering cases, the idea being that such an expert would be valuable for his private unbiased consultation with the court, the regular experts of the complainant and defendant being retained as usual.

The discussion was general, being participated in by the following gentlemen, all of them either experts or patent attorneys: Messrs. Edward S. Renwick, Edward P. Thompson, Jesse M. Smith, Charles L. Clarke and Clifford E. Dunn. The drift of the discussion appeared to be that competency and honesty were the two chief qualifications necessary; an expert in patent litigation must be intimately acquainted with all the claims in dispute and must know the exact shades of difference between them; he must also distinguish between the elements of an invention, in themselves perhaps unpatentable, and the patentable combination. With regard to the question of payment in case an expert is retained and decides not to give testimony after looking up the subject, the discussion tended toward the idea that the expert was entitled to his retainer, as he is morally bound not to take up the opposing side.

Following the discussion the preliminary report on the election of officers, noted in these columns last week, was read.

On Wednesday the 16th, the day following the business meeting in New York City, the seventeenth general meeting opened in Philadelphia with about twenty-five members present. The meeting was called to order in a lecture room of the Drexel Institute in the afternoon, shortly after the arrival of the delegation from New York City. The retiring president, Dr. A. E. Kennelly, appointed Prof. E. J. Houston and Mr. W. J. Hammer to escort the newly elected president, Mr. Carl Hering, to the chair. After a few words expressing his appreciation of the honor conferred by the institute upon him, President Hering introduced Dr. McAllister, of the Drexel Institute, who, in the absence of the Mayor of Philadelphia, welcomed the association to the city and to the building. Dr. McAllister called attention to the fact that the hall of the Drexel Institute was a fitting place for the meeting of the American Institute, as the former is devoted to artistic, technical and scientific training, and contains a modest school of electrical engineering.

After a few announcements by the secretary the paper on "A New Transmission Dynamometer" was read by the author, Prof. W. E. Goldsborough.

The dynamometer described was built and used in the electrical laboratory at Purdue University, and consists simply of a coiled or helical spring with the centre line of the helix corresponding with the centre of the shaft, this spring connecting the driving and driven members. To obtain readings, two instantaneous contacts were mounted, one on the driven and one on the driving shaft, connected in series with each other, and with a battery and telephone receiver. As the spring becomes deflected by a load the contact on the driven shaft falls back and the corresponding brush must be set back by the same angle in order to obtain a click in the telephone. This angle is a direct measurement of the torque, and can be calibrated at standstill. The paper gives several diagrams of results obtained on induction motors with this device.

This paper and the machine described in it greatly interested Mr. C. O. Mailloux, who expressed the opinion that the dynamometer described would, with certain modifications, have a much wider range of usefulness than that claimed in the paper. Comparing the new instrument with those used in the past, such as the Emerson and the Van Winkle, Mr. Mailloux pointed out the greater simplicity of the new form and its freedom from disturbances due to speed and centrifugal force. The chief lack of the new form, from Mr. Mailloux's point of view, is the absence of a visual, direct-reading indicator, and the necessity of hunting for the deflection for each reading. With fluctuating loads it is hard to set an instrument quickly enough to follow the fluctuations, unless a dash pot or its equivalent is used, which reduces the sensitiveness. Readings on varying loads might catch some points on the fluctuations, but would not give their extreme range, which is often wanted. A resonance or hunting effect might also take place between the driving and driven bodies through the elasticity of the spring, which effect would destroy accuracy unless the range of the oscillations were recorded. Mr. Mailloux suggested the use of a differential or epicyclic gear train—similar to that used on the Aron meter—to indicate the torque directly on a dial, with which attachment he considered that the instrument would find a wide use in practical work.

The next paper on the programme was that on "A Percentage Bridge," by Herschel C. Parker, of Columbia University. This paper described a means of calibrating rheostats by comparison with a standard resistance in such a way that all errors were determined directly in per cents. Prof. W. E. Goldsborough welcomed the new arrangement as a labor-saving device and a simplification of previously-used arrangements.

THURSDAY'S SESSION.

The first paper was that entitled "Conditions of Electrolytic Corrosion in Brooklyn," prepared and presented by Prof. Samuel Sheldon. The paper describes the distribution of potential differences between the rails and piping systems, an ingenious method of determining the resistance and therefore the current flow between the same networks, and the corrosion or rather absence of the same on cast-iron water-mains.

The report of the committee on units and standards, printed on another page of this issue, brought out considerable discussion.

Mr. Steinmetz considered that while names for the absolute units with prefixes to denote more practical magnitudes would be preferable to the present terminology, it would now prove a physical impossibility to change the custom in this respect, owing to the widespread use of the present terms in practice and commerce. In the matter of prefixes he strongly advised against the attempt to use one for every single power of ten, but considered preferable the use only of prefixes expressing the multiplication or division by 1000 or integral powers of 1000. For instance, in the present terminology the prefixes deci, deka, centi and hekto are little used, kilo and milli being generally used, all intermediate values being expressed numerically. Micro and mega serve to express multiplication or division by ten to the sixth power, but there are at present no prefixes to denote ten to the ninth power, and no words in either the Greek or Latin language to express this ratio. With regard to the rationalization of the units, Mr. Steinmetz proposed a new method based on giving such a value to the magnetic permeability of vacuum that the unit magnetic force, i. e., the attraction between unit poles over unit distance, should be equal to the unit force of gravity. The dielectric constant of vacuum should also be given such a numerical value that the unit electrostatic force would be equal to the same weight of unit mass. Mr. Steinmetz stated that he does not see the advisability of coming at present to rationalization in view of the fact that irrational units are now necessarily used; for instance, the metric system not being generally used in machine shops, all calculations of dynamo-electric machinery must be reduced from centimeters to inches, and until the metric system is adopted the full benefit of the c. g. s. system cannot be obtained.

The report of the committee on units and standards was accepted and ordered to be transmitted to the delegates of the International Congress at Paris for presentation before that congress.

The next paper on the programme was that entitled "Eddy Current

Losses in Transformers," prepared and read by Fitzhugh Townsend, of Columbia University. The paper gave results of tests which tend to show that the total iron losses of a transformer vary as the 1.6th power of the density rather than as the square, which is ordinarily considered to be the case. Knowing that the hysteresis losses vary as the 1.6th power, the assumption was drawn that the eddy current losses also vary as the 1.6th power. The paper describes experiments with a conducting loop imbedded in a mass of iron in such a way as to imitate as closely as possible the path of the current in a single lamination, the curve of current in this imbedded path being obtained. The paper plots the variations of total losses with the induction, and shows that the measured points fall very closely on 1.6th power curves.

Mr. Steinmetz did not agree with the reasoning or the conclusions but argued that eddy currents are ordinary secondary currents in which the energy loss must be proportional to the square of the impressed e. m. f.; the value of the mutual induction between the eddy currents and the exciting current having no effect on this proportionality. In particular cases, however, several contributory effects, such as the screening action of eddy currents, warming up of the iron, and consequent increased resistance, the stray magnetic fields with high densities reaching outside solid bodies, and the breaking down of the insulation between laminations; all may appear to make the eddy-current losses vary from the square, and in some cases approach the 1.6th power of the density. In other cases they might increase more rapidly than as the square of the density. The paper, however, shows that where there are complex secondary reactions the total losses can be represented as proportional to a simple exponential function of the induction. In the particular case of the transformers worked with by Mr. Townsend, this exponent appeared to be 1.6th, in other cases it might be 1.7th, or have some other value.

FRIDAY'S SESSION.

The first paper presented Friday morning was that by Messrs. F. A. C. Perrine and F. G. Baum, on "The Use of Aluminum Line Wire and Some Constants for Transmission Lines." That part of the paper on aluminum will be printed in a succeeding issue. The balance of the paper discusses the effect of the capacity of long-distance high-voltage transmission lines and the methods of neutralizing this capacity effect or charging current with inductive lagging currents. The paper discussed an extreme case of trouble due to capacity, the trouble being the inability to control the current consumed by a synchronous motor, which remained at practically full-load value with no load on the motor, no matter what the field excitation might be, the motor breaking out of step on the addition of load. The trouble was stopped by connecting reactive coils across the line, which passed sufficient lagging current to compensate for the charging current. When these reactive coils were put in place the synchronous motor took its proper current, and its angle of lag could be controlled by field excitation as usual. The authors of the paper ascribed this trouble to the effect of the charging current of the long transmission line on the impressed wave form of the alternating generators supplying it; assuming that the charging current flattened the wave form, causing a strong discrepancy between the voltage impressed upon the synchronous motor and the counter e. m. f. of the same machine, this discrepancy allowing a large current of higher frequency, upper harmonics, to pass through the motor.

In the discussion, Mr. Steinmetz stated that he did not believe that many difficulties alleged to be due to distorted wave forms were rightly explained, the character of the wave form being made a scapegoat for many troubles not otherwise explainable. The particular case described in the paper he explained as due to the same principle by which a transmission line with a length equal to one-half the wave length impressed upon it would give constant current regulation at the receiving end, constant potential being impressed at the transmitting end. This is an extreme case, but distributed capacity and self-induction even in shorter lines may give a similar effect. Dr. Kennelly described some of the results obtained from his tests of the aluminum wire mentioned in the paper. Of 100 samples, the electrical properties were very uniform, due apparently to the high degree of purity, the fracture of the wire invariably taking a peculiar form, with a long, central elongation giving a truncated conoidal end to the fractured wire somewhat like the end of the positive carbon in an open arc lamp. With a breaking stress of 1500 lbs., the elongation of pure aluminum is first apparent at about 200 lbs. The elastic elongation from which the metal recovers on the removal of the stress, is proportional to the stress, while the permanent elongation or set is about proportional to the square of the stress, and does not suddenly become apparent and serious as it does in other metals; therefore it is difficult to fix any definite value for the elastic limit. Concerning the electrical constants of transmission lines, Dr. Kennelly considers that the solution of the problem by means of concentrating the capacity is good enough for all ordinary cases, while in cases of excessive capacity or self-induction, or particularly in the investigation of the effect of harmonics, the problem requires the application of the hyperbolic functions, which give an accurate solution of all cases. A discussion arose between Dr. Kennelly and Mr Steinmetz as to what should be considered the forward direction of rotation in alternating-current diagrams, Dr. Kennelly objecting to the counter clockwise rotation, and presenting as an argument for the other the fact that alternating currents, electromotive forces, etc., are represented in such diagrams as a function of the time.

Mr. P. N. Nunn described some of his experiences with aluminum transmission lines in the West. In some cases of an extremely large number of breaks which showed a crystalline fracture, the indications were that the aluminum was not pure and that the alloy was not thoroughly mixed in the ingot. Mr. Nunn considers that the problem of joints in aluminum lines has not as yet been satisfactorily solved. Prof. Perrine mentioned a large number of breaks of this kind without a reduction of area which have come to his notice, the line in which they occurred showing about 10 per cent less conductivity than that of pure aluminum, showing that there was some impurity in the metal.

Following this paper Mr. Gano S. Dunn moved the appointment of a committee to draw up resolutions of thanks to the Philadelphia Entertainment Committee. The chair appointed Messrs. C. W. Rice, Geo. F. Sever and W. W. Kerr.

The next paper read was that of Capt. A. C. Crehore and Prof. Geo. O. Squier, on "A Practical Transmitter Using the Sine Wave for Cable Telegraphy; and Measurements with Alternating Currents Upon an Atlantic Cable." The paper describes in detail the sine-wave transmitter invented by the authors of the paper, and operating on the principle laid out by these authors and described in a paper already delivered by them before the Institute. The sine-wave transmitter consists simply of a bipolar single-phase machine with a distributed winding, the centre of which is brought out to a collector ring, the two ends being brought out to the two halves of the split collector ring. The armature of the machine is geared to a drum driving perforated tape similar to that of the usual Wheatstone automatic transmitter. The brushes bearing on the tape are connected with the line and machine in such a way that the perforations allow either positive or negative semi-waves of alternating current to pass through. Two complete machines of this type were exhibited in the convention hall in operation; one transmitting messages to a Wheatstone receiver and the other to a syphon recorder. The measurements described in the paper were made upon two cables of the Commercial Cable Company, one extending from New York City to Canso, Nova Scotia, a distance of 880 knots, the other running from Canso to Waterville, Ireland. One series of tests was made to determine the relation of the amplitude of motion of the syphon recorder to the frequency, the pressure remaining constant; it was found that with the shorter line mentioned above the amplitude fell from one-tenth of a square inch at a frequency of 3.5 periods per second to two-one-hundredths of a square inch at about 6 periods per second. Tests were also made to find the relation of the amplitude and impressed voltage at constant frequency; it was found that the vibrations of the receiver were directly proportional to the voltage within the limits of errors of observation. At different voltages varying from 5 to 30 the amplitude of vibration fell with increase of frequency at such a rate in each case as to indicate no vibration whatever at about 7 cycles per second in the case of the shorter line. There is not sufficient space in these columns to abstract the large amount of experimental work covered in this paper and the interesting deductions made therefrom. Phase measurements were made, giving the angles of advance, calculated impedances at different frequencies were compared with measured determinations, the paper ending with a comparison between the electromotive forces employed in the sine wave and the ordinary battery method.

The paper was discussed by Prof. M. I. Pupin, who pointed out the fact that the integral current time at the receiving end bears no relation to the integral sent into the cable, but only to the integral of the fundamental wave sent into the cable owing to the fact that the

harmonics are damped out to an enormously greater extent than is the fundamental. The method of Messrs. Crehore and Squier puts into the cable more available energy for the same maximum instantaneous electromotive force, which is the limiting factor in cable transmission, and puts in less total current to be discharged.

Dr. Frederick Bedell proposed in the discussion to use in place of the half-waves of alternating current, complete waves each side of the zero line of impressed voltage, that is to say, to impress upon the cable a positive wave consisting of a sine-square-shaped impulse instead of half of one sine impulse, claiming that this would introduce no sharp reactive point as does the sudden dip and following rise of two half sine waves immediately succeeding each other. Mr. Steinmetz cleared up this part of the discussion by the observation that succeeding half sine waves of the same polarity do not have the same effect on an electrical line as do complete sine waves. With a condenser in series with the source of supply to the cable, the absolute difference of potential impressed upon the cable at any instant is of no importance, the rate of change being the factor that affects the current flowing. Repeated half sine waves of the same polarity give a double frequency fundamental with the addition of upper partials. For the formation of ripples in a syphon recorder—record of such letters as H, for example—which in the usual code consists of four successive impulses of the same polarity—Dr. Bedell's proposed method would be more effective than that of Messrs. Crehore and Squier owing to the greater time of the dips between successive impulses, but it was pointed out in the paper that such letters are easily read without the ripples between the separate impulses constituting them, the double frequency impressed on the line by the successive half sine waves of the same polarity being too high for transmission is quite lost before reaching the recorder, which records simply the same effect as though a direct electromotive force had been applied in place of the successive half impulses.

Dr. Kennelly pointed out the fact that up to the present there have been no published accounts of any experimental check of Lord Kelvin's deductions as to the damping effects of the capacity of submarine cables on the impulses sent through them, this paper giving the first published records of such tests. Hitherto we have never had positive proof that the theory of the action of alternating currents on submarine cables was correct, now we have a working theory of the transmission of alternating currents over submarine cables as well as on overhead lines. In submarine work the speed is dependent on the time constant of the cable, which is proportional to the product of the electrostatic capacity and the resistance. This product of farads times ohms gives a quantity of the same dimensional order as time, and therefore can be measured in seconds. Cables having time constants of one second or less give no trouble in the matter of speed but with the long cables having time constants of six or seven seconds, apparatus of very great delicacy is necessary to obtain sufficient speed to make the cable commercially profitable. To show the effect of the time constant on speed of signaling, and particularly on the transmission of the harmonics of impressed electromotive force waves, Dr. Kennelly mentioned the fact that a cable with a constant of 4.7 seconds gives 1000 times as great impedance to the triple harmonic of the usual frequency of about 4 periods per second as it does to the fundamental, the higher harmonics being impeded to an even greater extent. In submarine telegraphy the object sought is very different from that of the usual transmission of electrical energy. Instead of aiming for the highest efficiency at any frequency the cable engineer wishes only 30 microamperes of current at the highest available frequency with a given impressed e. m. f. Under this condition the advantage of the sine wave over the square-cornered wave is not so great as though efficiency were alone aimed for. Dr. Kennelly concludes that even if the labors of the authors of the paper do not bear fruition in the commercial adoption of their system, the scientific world owes them a debt of gratitude for the scientific demonstration which they have given of the conditions of their work and the valuable data accompanying it.

The next paper presented was one on "Telephony Over Cables and Long-Distance Air Lines," by Dr. M. I. Pupin. The work of Dr. Pupin in this line had been previously brought to the attention of the Institute by the paper presented in March, 1899, in which the attenuation of electric waves on long-distance lines was discussed mathematically. The fact that this attenuation could be reduced by distributed inductance was first brought to the attention of the scientific world by Mr. Oliver Heaviside. As it is impossible to obtain sufficiently high inductances for practical work uniformly distributed throughout the line, experiments have been made in the direction of inserting inductances at several or many points, but these experiments have proved unsuccessful on account of wave reflection from the induction coils, which were insufficient in number. Dr. Pupin's papers before the Institute are the first to discuss mathematically the necessary extent of the division of the inductances to give good effects. In addition to this mathematical determination the paper describes experiments made with an artificial line in the electrical laboratories of Columbia University. The line consisted of 250 sections, each having a resistance of 9 ohms and a capacity of 4.7 microfarads, each section thus resembling closely one mile of overhead telephone line. In addition to this cable there were 250 inductive coils which would be connected between the cable sections. With the inductance coils removed the transmission was good up to 50 miles, fair up to 75 miles, impracticable at 100 miles, and impossible at distances over 112 miles. With the coils connected into the line, telephony was carried on with perfect ease over the whole length of the cable, 250 miles, the articulation being so clear that the speaker could stand back a considerable distance from the mouthpiece of the transmitter, indicating that a considerably greater length of line, such as 350 miles, could have been in the circuit if it had been available.

Mr. Steinmetz opened the discussion with the statement that the information contained in the paper was extremely important and a decided advance in telephony. In a paper which was presented some years ago before a scientific association, discussing the possibility of telephoning across the Atlantic, the proposal was to shunt distributed inductances across the line. Since, however, reactance is proportional to the frequency, while the negative reactance of capacity is inversely proportional to the frequency, the two can only balance for one frequency, whereas telephony involves many. With the inductances in series with the capacity, one could be made to balance the other for all frequencies, thus making a distortionless circuit, i. e., a circuit in which the phase relation between the e. m. f. and current does not change throughout the length of the line. The two problems of electrical transmission, one of large powers with high voltages and low frequencies, and the other of small powers with low voltages and high frequencies, are essentially the same, but the magnitude of the constants involved being very different the solution is totally different. In the former it is notable that engineers were first bothered by self-induction in the attempt to cure which they used capacity. The attempt was a failure, as the necessary conditions were not worked out mathematically. In complicated work of this kind, theory must lead experiment. The same problem is now solved by means of synchronous machines giving a capacity effect. In telephone work the capacity effect is comparatively large and the induction small. In telephony also, the wave length is comparable with or smaller than the length of the lines. Although a certain amount of distributed self-induction makes the circuit distortionless, it is not necessary to have exactly this amount for improvement of operation. Any addition of distributed self-induction improves the operation until this best or critical amount is reached, any further addition again reducing the ease of transmission, but there is a wide range either side of the best value, in which range nearly as good effects are obtained.

After the discussion of this paper the Institute adjourned, to meet in Paris, Aug. 16.

A. I. E. E. Election.

Owing to the large number of ballots cast at the recent election of the American Institute of Electrical Engineers, and the somewhat complicated character of the vote, the official declaration of the result of the balloting was not made, as heretofore, on the evening of the annual meeting in New York, the announcement being reserved for the Philadelphia meeting.

The total number of voting envelopes handed to the tellers by the secretary was 666. Of this number 51 were rejected for the following causes:

Enclosed in unendorsed envelopes, 24 votes; duplicates, 25 votes; one vote by proxy and one vote of an ex-member, whose resignation had already taken effect. In the case of duplicates, the one bearing the earlier date was rejected according to the established custom of the institute. Of the 615 envelopes opened, 32 contained ballots unenclosed in an inner envelope, and seven contained in an

inner envelope were signed by the voters. These 39 were also rejected, leaving 576 ballots to be counted.

Of the presidential votes, 381 were cast for Mr. Carl Hering, 179 for Dr. Pupin, and 16 scattering. For vice-presidents, 544 were cast for Mr. G. S. Dunn; 539 for Mr. A. V. Abbott, and 526 for Mr. W. L. R. Emmet. There was also a scattering vice-presidential vote for 42 other names, the highest number of ballots being 12.

The vote for managers was as follows: Mr. W. S. Barstow, 553;

CARL HERING, PRESIDENT AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Mr. R. D. Mershon, 530; Mr. C. W. Rice, 534, and Mr. C. T. Hutchinson, 319. Votes were also cast for 45 other candidates, the largest number—261—being received by Mr. J. J. Carty. For secretary, Mr. Ralph W. Pope received 574 votes, one vote being cast for each of two other names. For treasurer, George A. Hamilton received all the votes cast—576 in number.

A Tesla Patent.

The accompanying illustration is reproduced from a patent granted May 15 to a Nikola Tesla on an "apparatus for transmission of electrical energy." *D D'* are terminals of large surface maintained by such means as a balloon at a high elevation, the elevation depending upon the amount and quality of the work to be preformed, the con-

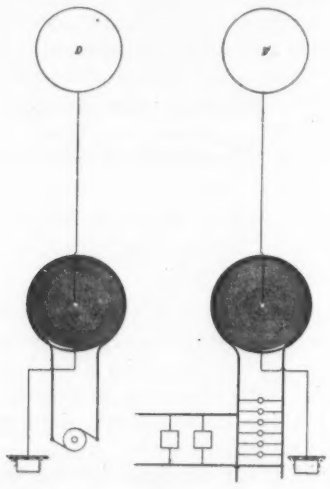


DIAGRAM OF TESLA APPARATUS.

dition of the atmosphere, and also by the character of the surrounding country. The aerial conductors to these terminals are connected to the secondary of a spiral coil, the other end of the coil being connected to earth.

It is stated that the length of the thin wire in each of these coils should be approximately one-quarter of the wave length of the electric disturbance in the circuit, this estimate being based on the velocity of the propagation of the disturbance through the coil itself and the circuit with which it is to be used. For example, if the rate at which the current traverses the circuit including the coil be 185,000 miles per second, then the frequency of 925 miles per second would maintain 925 "stationary moves" in a circuit of 185 miles long, and each wave would be 200 miles in length. For such a low frequency, a secondary 50 miles in length would be used.

As will be noted from the illustration, the primary of the transmitting coil is supplied with a current by a dynamo, and the large coil of the receiver is connected with a circuit including lamps and motors. It is stated that the phenomenon involved in the apparatus is one of true conductions and not to be confounded with the phenomena of electrical radiation which have heretofore been observed, and which from the very nature and mode of propagation will render practically impossible the transmission of any appreciable amount of energy to such distances as are of practical importance. The specification states that if the potential is sufficiently high and the terminals of the coil be maintained at the proper elevation where the atmosphere is rarefied, the stratum of air will serve as a conducting medium for the current produced, and the latter will be transmitted through the air "with, it may be, even less resistance than through an ordinary conductor."

Telephone Combination on the Pacific Coast.

A despatch from Portland, Ore., states that all of the Bell licensee companies on the Pacific coast have been combined, under the name of the Pacific States Telephone & Telegraph Company. The capital stock of the new concern, which was organized under the Oregon laws, is $15,000,000. The incorporators are John C. Ainsworth, J. H. Thatcher, John Lawrence, George B. Bush and F. R. Strong, but the head of the concern is John I. Sabin, of San Francisco.

The properties taken are: Pacific Telephone & Telegraph Company, of San Francisco, which covers San Francisco, Oakland, Alameda and smaller cities around the bay of San Francisco; the Sunset Telephone & Telegraph Company, of San Francisco, which owns all the Bell exchanges in California, outside of San Francisco Bay; the Oregon Telephone & Telegraph Company, which owns the Portland and all other Bell exchanges in Western Oregon; the Inland Telephone & Telegraph Company, which covers Eastern Oregon and Washington, and in Idaho; the Sunset Telephone & Telegraph Company, of Seattle, covering Western Washington.

These companies also own practically all the long-distance lines in the States mentioned, reaching from Boise City, Idaho, via Portland, to San Diego, Calif., a distance of nearly 2200 miles.

CURRENT NEWS AND NOTES.

THE SOUTHERN RAILWAY TELEGRAPHERS' STRIKE.—The strike of the operators on the Southern Railway system, which was ordered some weeks ago, has been discontinued by the president of the Railway Telgraphers' Order.

TRIFLING FIRE AT THE PARIS EXPOSITION.—A slight fire occurred in the Chateau d'Eau, at the Paris Exposition, on the afternoon of May 15. The damage is reported to have been slight. The first reports of the occurrence received in this country were greatly exaggerated.

CINCINNATI FESTIVAL.—A Fall Festival will be held in Cincinnati for ten days, beginning Sept. 19, and one of the features will be a brilliant electric pageant, which is promised to be the finest ever witnessed in this country. It is probable that all the local electrical manufacturing establishments will co-operate with the general committee of the Festival Board in an effort to make the affair a notable one electrically.

THE CANADIAN ELECTRICAL ASSOCIATION has been forced to postpone its convention, which was to be held at Ottawa in June, until next fall. Owing to the disaster at Ottawa it will be impossible to hold the convention there at the appointed time, and as no other town was prepared to become the place of meeting, President A. A. Dion stated that it was thought best not to come to an immediate decision.

TELEPHONE TARIFF IN WURTTEMBERG.—Consul General Guenther, at Frankfort, and Consul Hughes, at Coburg, report to the State Department that the annual charge for telephones in Wurttemberg has been reduced to 80 marks ($19.04). The cost for a five minutes' talk over the local circuit is 5 pfennigs (1.19 cents); for a distance not exceeding 15 kilometres (9⅜ miles), 10 pfennigs (2.38 cents); up to 50 kilometres (31¼ miles), 20 pfennigs (4.76 cents); for longer distances, 50 pfennigs (11.9 cents).

ELECTROLYTIC MANUFACTURE OF CAUSTIC ALKALI.—In a patent granted May 15 to C. E. Acker, an electrolytic method is described for manufacturing caustic alkali and halogen gases. The salt to be treated is supplied continuously in a molten condition to an electrolytic furnace, where it rests on a body of molten lead constituting the cathode. An alloy of sodium and lead is formed at the common surface, and in another part of the furnace this alloy is decomposed by the action of steam, into soda and hydrogen. The process is continuous, a circulation being set up in the furnace such that the impoverished alloy is returned to where it will again take up alkali metal.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY SUMMER COURSE.—During the months of June and July of this year, the Massachusetts Institute of Technology will give a series of courses, primarily for the benefit of students wishing to gain time for advanced work during the regular term, and for those who have deficiencies to make up. The courses are open to other than students of the Institute if they possess the necessary qualifications. The fee is $25. Among the course is one on electrical testing, in charge of Frank A. Laws, S. B., assistant professor of electrical measurements, and consisting of laboratory practice from 9 a. m. to 1 p. m. daily, beginning June 6 and ending July 5.

AUTOMOBILE REGULATORS.—A motor constructed to receive a normal difference of, say, 80 volts at the terminals, does not work efficiently when this voltage is departed from. In a patent granted May 15, to M. J. Barreau, of Paris, a system of motor control is patented having for an object to maintain the inducing magnetic flux or current constant. To this end the windings of the field magnets are divided into sections, and the storage battery similarly divided. Supposing a motor intended to operate at three different rates of speed, its field magnet windings would be divided into four sections and the battery into the same number. By means of a controller these sections are coupled in parallel according to the speeds to be obtained.

VISIT TO METROPOLITAN POWER HOUSE.—Through the courtesy of Mr. M. G. Starrett, chief engineer, the New York Electrical Society will visit the new power house of the Metropolitan Street Railway Company, at Ninty-sixth Street and First Avenue, on Friday evening, May 25. Members will assemble at 8.30 in the car barn building, near the power house, half way between Ninty-sixth and Ninty-seventh Streets. Here they will be addressed by Mr. Arthur Mann, who has superintended the mechanical engineering of the station, and by Mr. William A. Low, who has had charge of the construction of the foundations, buildings and chimney. After the description of the plant by these gentlemen, the members will proceed in groups to the power house.

ELECTRIC HEATING CONDUCTORS.—A patent granted May 15 to W. S. Hadaway relates to means for sustaining and protecting an electric heating wire when located in or upon a heater body, so that the insulation may be thoroughly preserved and the heat from the wire be conducted efficiently to the heater body. These objects are effected by packing iron or steel particles about the insulated wire, and then oxidizing the same, the particles being mixed before packing with sal-ammoniac and water, which readily causes the formation of iron chloride, which rapidly oxidizes the iron and cements the particles into a solid mass. The heating wires are first insulated by dipping them a number of times into a cream-like mixture of porcelain clay and water, and then baking, which converts the clay into porcelain, which may be glazed afterwards.

INDEPENDENT TELEPHONE EXPANSION.—It is believed in telephone circles in New York that the Telephone, Telegraph & Cable Company of America is interested in the negotiations for the acquisition of the franchise of the Illinois Telephone & Telegraph Company, which, according to rumor, is to be sold to an Eastern syndicate. It is reported that President Coffin, of the General Electric Company, is conducting the deal, and he is said to represent directly Messrs. Maloney, Widener and Elkins. Some assert that the acquisition of this franchise will result in forcing the Chicago Telephone Company to sell. Touching these rumors, President Wheeler, of the Illinois Telephone & Telegraph Company, is reported as saying that there is absolutely nothing in the story that the company is for sale. Under ironclad agreements and by law the company cannot be sold until complete and in operation.

ARC LIGHT CARBON.—A patent issued May 15 describes a form of arc light carbon designed to give a steady, lasting, economical and agreeable light with less e. m. f. than is required in existing systems of electric lighting. In making the carbons pulverized coke or lampblack is mixed with 1 per cent of calcium oxide of magnesium, and the same amount of phosphate of calcium, together with a binding material. After gently heating, the resulting brittle substance is pulverized, then shaped into sticks of carbon and fired. For direct-current circuits the carbons are supplied with a core similarly made, and composed of a material which will give a higher resistance than the carbon proper, such as lampblack mixed with phosphate of magnesium or calcium. It is claimed that with the cored type of carbon the mechanism usually employed with arc lamps may be dispensed with, as the current regulates itself.

REGENERATED PRIMARY BATTERIES.—The broad idea of bringing the exhausted liquids of a primary battery and the dissolved zinc back to their original condition by a chemical, thermal or electrical process, has often been suggested. Among the many difficulties encountered was that owing to the diffusion of the two liquids in a two-fluid cell, each will gradually be contaminated by the other, and become less active with each regeneration. Two patents issued May 15 to Messrs. Hess, Shinn & Hering, describe a method to overcome this through the use of a depolarizer consisting of a mixture of equivalent parts (i. e., equivalent in ampere-hours' capacity) of the excitant and the depolarizer. For the exciting liquid, this same liquid is used after having been in a preceding discharge exhausted as a depolarizer; the same liquid is thus used first, as a depolarizer, then as an excitant. In the regenerative process the zinc is extracted by electrolysis, and at the same time another batch of exhausted liquid from which the zinc has already been extracted, is oxidized electrolytically, so that the depolarizer becomes active again. It is claimed that no matter how great the diffusion of the two liquids, they will not be changed in the relative amounts of the excitant and depolarizer which they contain; and that this will be true even if the diaphragm should be broken and the liquids become completely mixed. The process thus becomes a completely cyclic one, which can be repeated indefinitely, as far at least as the relative composition of the liquids is concerned.

LETTERS TO THE EDITORS.

Defective Oil Rings.

To the Editors of Electrical World and Engineer:

Sirs:—I should like to say a word in regard to oil rings, or self-oiled bearings on motors, generators, etc. The writer has seen hot bearings and considerable trouble arising from defective oil rings, where the ring was split or made in two parts. There are hundreds of bearings having oil rings which will not start to turn until the machine has attained full speed. Sometimes it is necessary to give the ring a start by hand. The trouble can be attributed to the fact that the two halves are cast at different times, one-half of the ring being more dense—consequently weighing more than the other half. When the ring is machined, the two halves are exactly the same size, but it will be found that the ring may not turn. The manufacturers do not seem to have given this matter the attention it should have. The writer considers that all oil rings should turn at 25 per cent of full speed of the machine.

Another difficulty is caused by the material used in making the ring, which is generally brass or bronze, and the slightest blow will put the ring out of "true," making it rather difficult for the average man to get it in proper shape again. It seems that a steel ring, brass lined, would be preferable on this account. Recently, out of sixteen bearings on new machinery, the writer found thirteen bearings having rings that would not turn until almost full speed was ob-

tained, and the two halves of the rings were not of the same weight.

It seems if manufacturers gave this question a little more thought, it would save them and their customers considerable annoyance and expense.

Geo. R. Colman.

Philadelphia, Penn.

Secondary Transformer Magnetic Leakage.

To the Editors of Electrical World and Engineer:

Sirs:—It is surprising to find in these days a dissenter from the generally accepted ideas as to the effect of magnetic leakage on the regulation of transformers. In his letter, published in your issue of May 19, Mr. Joseph Bijur questions the influence of the leakage fields on the regulation. Having read his letter and his article of March 27, 1897, I cannot see that his conclusions are justified. The difference in the readings of his two test coils wound alongside of the primary and secondary wires does not indicate the amount of magnetic leakage.

Magnetic leakage is generally defined as the lines of force which pass through one coil and not through the other; thus when under load both primary and secondary coils may set up leakage fields. It is thus seen to be possible that each coil may have the same number of lines passing through it, and still all of the lines of either coil need not be common to them both. Thus, each coil may be considered as encircled by two fields, the main core flux common to both coils and the leakage flux of the particular coil considered. Where the primary and secondary coils are even approximately alike in shape and space occupied, the leakage fields are practically the same, so that it is natural that the difference in the readings of the two coils in Mr. Bijur's experiments should be very small. It is the sum of the leakage fields that is important; this sum cannot be got from the readings of such test coils, as each reading contains the effect of the main core flux.

As has been repeatedly pointed out, the leakage fields are simply sources of self-induction in each coil, and so with leading or lagging currents cause a decreased or increased drop over that due to resistance. Mr. Bijur does not state how great was the falling off in the reading of the primary test coil with increasing load, but this was probably the effect of the ohmic drop in the main primary winding. The test coil acted as a secondary, giving the somewhat curious case of a transformer whose secondary was open-circuited and yet whose primary carried its full load current, and so gave an ohmic drop in the primary coil alone, which appeared at the secondary terminals.

John B. Whitehead, Jr.

Johns Hopkins University.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

By CARL HERING.

Dynamos, Motors and Transformers.

Electric Motors.—Mavor.—An abstract of a paper read before the Glasgow Section of the Brit. Inst. of Elec. Eng. on some considerations concerning electric driving. He dealt with small motors on 100 and 500-volt supply. Motors from 5 horse-power upward present no difficulties, but those under that size, particularly shunt machines, do. He pointed out the chief features of a ½-hp motor having an armature 5 ins. diameter by 3 ins. long, either series or shunt wound. When series wound, the motor is cheaper, the efficiency better, and consequently the working cost lower; it has greater starting torque, and can therefore start against a load with less current; the starting resistance can also be cheapened, as the small series motor has sufficiently high internal resistance to render a large external resistance unnecessary. In the discussion which followed, Chamen said that in arranging the starting resistance of small shunt machines, the end of the shunt coils should be connected to the first stud of the regulating resistance, as by this means the field coils were always short-circuited on the armature and a path provided for the e. m. f. induced when breaking the shunt circuit, which elementary precaution is often overlooked. McWhirter drew attention to the remarkable way in which a shunt motor would carry an overload; series motors prove of most value when they have to work against a fixed load; under other conditions a shunt machine is necessary. Watkinson spoke of the difficulty in getting different speeds, and said that in many industrial operations variable speed with constant torque would be necessary, yet so far there seemed to be no effective method of obtaining this in a satisfactory way. Stewart said that he had made some investigations to ascertain how far it was possible to obtain speed regulation with shunt machines, by introducing a resistance into the field coils and so reducing the available magnetic induction; in some types of machines it was possible to get a 25 per cent increase of speed, while with others only a few per cent increase was obtained. Moore replied that the switch arrangement mentioned by Chamen was satisfactory only with e. m. fs. less than 250 volts and with fairly large motors; smaller machines for high voltages had armatures wound with so many turns of fine wire that the self-induction of the armature was almost as great as that of the field coils, and the most satisfactory way was to put several lamps in series across the machine when it was switched off, thus providing an alternative path of high resistance for the e. m. fs. induced in the armature and field coils.—Lond. *Elec. Eng.*, May 4.

Starting Switches for Continuous Current Motors.—Krause.—An illustrated mathematical article on the determination of the steps of starting switches for continuous current motors. The current supplied to the motor should not surpass a certain value, and a minimum amount of resistance material is to be used. His calculations are made under the supposition that the crank of the starting switch is turned with uniform speed. He shows that by dividing the whole resistance of the switch into equal parts for the single steps, it is impossible to fulfil the requirement that the motor is always supplied with a current below a certain value; he also shows why, if the steps are not chosen accurately, there is sparking, especially on the last steps; this sparking is due to the inaccuracy in choosing the steps and cannot be diminished by turning the handle more slowly on the last steps. He shows how to determine the resistances for the single steps for a given value of the current which is allowed, and explains his equations by diagrams.—*Elek. Zeit.*, Apr. 26.

REFERENCE.

Synchronous Converters.—Meyer.—An English translation, with illustrations, of the German article abstracted in the Digest, May 5.—Lond. *Elec. Eng.*, May 4.

Lights and Lighting.

Nernst Lamp.—F. Sch.—A continuation of the well-illustrated article abstracted in the Digest Mar. 24 and Apr. 14. To prevent the loss of energy in the resistances to be connected in series with the incandescent bodies (Digest, Mar. 24), the British Thomson-Houston Co. proposes to connect the lamps in series in a circuit of constant current, a resistance or induction coil being connected in parallel with each lamp, which can be short-circuited and gradually switched in or out. In shunt to each lamp there is also an automatic short-circuiting device which consists of two contacts separated by a leaf. To light a lamp which is short-circuited, a resistance in shunt is switched on gradually; the heating body is supplied with current and heats the incandescent body, until eventually the shunt resistance is disconnected; in case that the incandescent body is destroyed, the lamp is at once again short-circuited by the automatic device. The resistance and switches are fixed in the socket; there is a special device used to prevent the switch being turned too quickly. If the heating body is connected in parallel to the incandescent body which is in series with an electromagnet for automatically interrupting the heating body circuit, then in the possible case of destruction of the incandescent body, the circuit of the heating body is closed again and there is waste of energy and danger that the heating body may be destroyed. To prevent this, an Austrian company has patented an automatic circuit breaker, which

is illustrated in eight different forms. In the simplest form it consists of a coil in series with the heating body; the interior of the coil contains a fuse wire. In other types the coil is in a small case filled with air or a liquid and closed by a membrane, which by swelling out operates a lever. In a lamp of Brown the incandescent body is placed in the bore of two electrodes of carbon or metal; when the current is switched on, an electromagnet attracts one electrode, an arc is formed, which heats the incandescent body, until the arc is broken and the whole current goes through the incandescent body. In a comparatively simple lamp of Siemens & Halske the heating is also done by an arc. The incandescent body is placed between two electrodes, all three being in a vertical line. The upper electrode is connected in series with an electromagnet; against the lower electrode rests the longer arm, formed of carbon, of a nearly vertical lever, while the upper smaller arm is exposed to the attraction of the electromagnet. The lever arm of carbon is connected in parallel with the incandescent body. If the lamp is switched on, current flows through the carbon rod and the electromagnet, which attracts the lever, so that the carbon rod is removed from the lower electrode and an arc is formed. This arc rises gradually and heats the incandescent body until it becomes conducting in its whole length, when the arc is extinguished.—The lamps in which the heating of the incandescent body is done by an arc, have the advantage that they yield light at once when they are switched on; they first act as arc, later as incandescent lamps. In the lamps, in which resistances are used as heating bodies, it generally takes some time until the lamp gives light. To obviate this, heating bodies may be used, which are incandescent at the same time, especially carbon threads. In one type the incandescent body is placed in a glass cylinder which is closed at its lower end and open to the air at its upper end and which is placed in the interior of an exhausted globe, such as is generally used for incandescent lamps; around the glass cylinder the carbon thread is wound. If both the incandescent and the heating body are in the globe open to the air, threads of silicium or carbide of silicium may be used which have a life of some hours when glowing in open air, which is sufficient for this purpose.—*Elek. Anz.*, Apr. 22.

Combinations of Arc Lamps.—GIRAULT.—The conclusion of his article (Digest, Apr. 28). He shows analytically that with lamps which regulate for constant pressure, greater variations of current are obtained than with lamps which regulate for constant apparent resistance, or differential lamps. He draws the following conclusions for practical combinations of arc lamps on constant pressure distribution systems. First, it is possible to raise the pressure of an installation of 70 volts, in order to connect two lamps to the circuit instead of one, whatever may be the type of the primary lamp; if it is a lamp regulating for constant current, either a lamp regulating for constant pressure or a lamp regulating for constant apparent resistance, may be connected as the second lamp to the circuit; if the primary lamp is one regulating for constant pressure, or a lamp regulating for constant apparent resistance, a lamp of either of these two types may be connected as the second lamp in the circuit, or preferably a lamp regulating for constant current. Second, if an installation which comprises lamps regulating for constant pressure and lamps regulating for constant apparent resistance, does not work well on account of large variations of current, it may be advantageous to replace the lamps regulating for constant pressure by lamps regulating for constant apparent resistance, or better, by lamps regulating for constant current, either all of them or only a part. Third, it is often possible to change an installation of two lamps at 110 volts into one of three lamps under the same pressure by adding a convenient lamp regulating for constant current. Fourth, in new installations the three different types of arc lamps may be combined to advantage in the same circuit, under proper considerations of the special conditions of the case. Regarding combinations of arc lamps on constant-current distribution systems, he makes the following remarks: The circuit may contain any number of lamps regulating for constant pressure or lamps regulating for constant apparent resistance; but the former type had better be avoided.—*L'Ind. Elec.*, April 10.

Electric Buoys.—MUELLENDORFF.—An illustrated description of buoys provided with signal lamps which are lighted electrically from the shore. High-tension alternating current is used in order to make the cross-section of the copper cables so small; a proper thickness of the insulation is obtained, and the cable is made strong, so as to guard against breaking in stormy weather. Such buoys have proved satisfactory for three years on the Island Wangeroog in the North Sea. They are supplied with current from the station, which furnishes the current for two lighthouses, eight miles apart. The voltage of the current for the buoys is 500, that for the next lighthouse 110, while the voltage for the transmission line to the other lighthouse is 2000.—*Zeit. fuer Beleucht.*, Apr. 10.

REFERENCE.

Incandescent Lamps.—WILLCOX.—A continuation of his long Franklin Institute paper in full (Digest, April 14). This part deals with the widened field of lamp use, the better understanding of lamps and the advance in methods of lamp testing (see the abstract in the ELEC. WORLD AND ENG., Jan. 6).—*Jour. Frank. Inst.*, May.

POWER.

Electrically-Driven Centrifugal Pump.—A description of a large centrifugal pump driven direct by means of two-phase induction motors of 1000 horse-power, used to lift water to the height of 460 feet in the waterworks at Coulonvrenier, near Geneva. The necessary pressure is obtained by a simple tandem arrangement of two centrifugal vanes. Injectors are used to fill the pumps, which are started up with closed valves; when the normal speed of 600 r. p. m. has been attained, the valve is slowly opened, and the lifting commences. The pump delivers 5000 gallons per minute.—*Schweiz. Bauzeit.*; abstracted in Lond. *Elec. Eng.*, Apr. 27.

REFERENCES.

Steam Turbines.—DE SEGUNDO.—A brief article on the efficiency of the direct-coupled steam turbine, referring to tests of three 500-hp turbines, coupled direct to 300-kw alternators, at the plant of the Westinghouse Air Brake Company.—Lond. *Elec. Rev.*, Apr. 27.

Blast Furnace Gases.—An article on the utilization of blast furnace gas for the generation of power by gas engines. The main points of a report of Prof. Meyer are abstracted.—Lond. *Elec. Rev.*, Apr. 27.

Water Power in Russia.—A note stating that an English company proposes to carry out an important hydraulic scheme on the river Dnieper, in Russia, where it branches off from a southeasterly to a southwesterly direction in order to flow into the Black Sea, and where there is a succession of rapids. It is proposed to render the waterway navigable by constructing locks at the spot, and to utilize the power of the rapids for the generation of electric power.—Lond. *Elec. Eng.*, Apr. 27.

Power Schemes in Great Britain.—The first part of an article on projected electrical power schemes, illustrated by maps and giving information about the sizes of areas to be supplied and about the rates of charging. The systems of distribution are not referred to.—Lond. *Elec.*, May 4.

Electric Power Transmission in Workshops.—BOWDEN.—The first part of the illustrated paper in full, an abstract of which was noticed in the Digest, Feb. 10.—Lond. *Elec. Eng.*, Apr. 27.

TRACTION.

Road Locomotion.—HELE-SHAW.—A brief abstract of a paper read before the Brit. Inst. of Mech. Eng. The difficulty of electric automobiles lies in the battery. The merits of any accumulator should be judged to a great extent by its condition after six months' daily use in a motor vehicle. So long as only a range of 40 miles per charge at speeds not exceeding 10 miles per hour, are required, electricity at a cost of not more than 4 cents per kw-hour is, at least, on a par with steam or oil, even for heavy traffic. Above these limits, however, electricity is said to be impracticable. Better results have been obtained by electric vehicles in individual cases on long runs, but the batteries are said to have been completely destroyed and to be useless afterwards.—Lond. *Elec. Eng.*, May 4.

Accumulator Traction.—A note stating that the Bristol-road section of the Birmingham tramways, which is said to be the last English line using accumulator traction, is apparently to be superseded by the overhead trolley system.—Lond. *Elec. Eng.*, May 4.

Automobile Run.—A note on a 1000-mile run which has just begun and has been arranged by the Automobile Club. Nineteen days are allowed, so that the average daily run is only about 52 miles. The test is to be of endurance, not speed.—Lond. *Elec. Rev., Elec. Eng.*, Apr. 27.

Zuerich.—EDSTROEM.—A very well illustrated article on the trolley lines of Zuerich. The building of the road, the rail joints, the overhead conductors, and the rolling stock are described in detail.—*Elek. Zeit.*, Apr. 26.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Electrical Equipment of Warships.—GROVE.—The continuation and conclusion of the long abstract of his paper (Digest, May 5), dealing

with the use of electricity for driving auxiliary machinery. The power requirements are given in the following summary, in which the first figures mean the total motor capacity installed, including duplicates, in e. h. p., the second, this same capacity with duplicates excluded; ship ventilating fans, 40, 40; engine and boiler-room fans, 100, 100; furnace air-blowing engines 200, 200; steering engines 400, 200; forward capstan 120, 120; after capstan 50, 50; boat hoists 100, 100; coal hoists 100, 100; ash hoists 20, 20; workshop engines 5, 5; air compressors 200, 100; turret motors 500, 300; ammunition hoists for 6-in. and smaller guns 50, 50; total 1885, 1385. If these figures err, they do so on the right side, and in working out details, savings both in power and weight could probably be effected. An installation of 802 to 850 kilowatts would leave an ample margin of spare plant under all ordinary circumstances, and this is said to be an equipment not at all unlikely to be called for in the near future. He does not advise the multiplication of 50-kw sets, though it will always be advisable for a battleship to carry a few of these sets to be used for lighting and ventilation when nothing else is being done, for working searchlights and for the regulation of turret and steering motors. For an 800-kw installation he advises three generating sets of 200 kilowatts each, and four sets of 50 kilowatts. As to the system of distribution, he considers the relative advantages and disadvantages of continuous and polyphase current to be nearly evenly-balanced. The question of the voltage standard is more difficult; he hesitates to recommend the introduction of a three-wire system on board ship, and prefers a direct circuit of 160 volts for both lamps and motors; having gone so far, one might as well accept the 200-volt standard at once. As to weight, he shows that the substitution of electricity for steam, for all auxiliary engines, would result in the saving of 262 tons of coal for every 25 days' steaming, so that although the substitution might involve approximately 55 tons of additional weight, there would be a good balance in favor of electricity. The space required for the generators continues to be one of the difficulties in the present arrangements of a battleship.—Lond. *Elec. Rev.*, Apr. 27, May 4; the illustrated reprint of the full paper is concluded, and an abstract of the discussion which followed is given in Lond. *Elec. Eng.*, Apr. 27; continuations of the illustrated reprint of the full paper in Lond. *Elec.*, Apr. 27, May 4.

Dortmund.—DICK.—The first part of a well-illustrated description of this modern German central station. In the urban area electricity is supplied by continuous current, while in the outer zone three-phase distribution is used both for light and power. The very general use of motors and the relatively large amount of electricity supplied for motive power are noteworthy. The continuous-current dynamos are of the twin type. The field magnet of each dynamo has 30 poles and the two armatures are entirely distinct from each other electrically. Each half of the twin machine has a capacity of 200 kilowatts, with a voltage that can be varied from 220 to 370 volts. Each half can be used quite independently, or the two halves may be coupled in parallel to feed the outers of the three-wire system, or to charge the batteries. When the electric trams are supplied by the municipality, the two armatures can be coupled in series, to furnish a pressure of 440 to 740 volts. Such a type of machine thus overcomes the difficulty of using the same plant for both lighting and traction; in England the same problem has been solved by introducing a 500-volt distribution on the three-wire system for lighting. There are three accumulator sub-stations, one forming a part of the main station building, and the two others being distant about 2000 and 1800 yards respectively from the central station. Each station has 132 cells, the first sub-station has a capacity of 3536 ampere hours, the maximum discharge current being 833 amperes, and the maximum charging current 720. The other two sub-stations are of half this capacity and the joint output of all three when running at full load is equal to 370 kilowatts. The efficiency of the battery is 90 per cent in ampere hours and 80 per cent in kilowatt hours. All batteries are charged directly from the central station without the intervention of boosters or synchronous converters.—Lond. *Elec.*, May 4.

Darmstadt.—A long abstract of the last annual report of the municipal electric plant of Darmstadt, Germany. During the year 716,461 kilowatts were generated; the maximum generated in 24 hours, on Dec. 15, being 3466 kilowatts, the minimum, on July 24, being 1091 kilowatts; at the hour of the highest consumption of power, in the evening of Dec. 22, 485 kilowatts were consumed. The accumulators were in use for 1522 hours; the charging amounted to 711,875 ampere hours and 94,394 kilowatt hours, the discharging to 677,628 ampere hours and 67,866 kilowatt hours.—*Elek. Zeit.*, Apr. 26.

REFERENCES.

Sarajevo.—A very long and fully illustrated series of articles on Bosnia and Herzegovina, covering two large issues of the journal (March 31, April 15), contains an illustrated description, by Demenge, of the electric station of Sarajevo. For lighting, the three-wire system at 2x110 volts is used; for traction the trolley system at 300 volts. Two electric locomotives are used for transporting freight between two stations.—*Rev. Gen. des Sciences*, Apr. 15.

Isolated Plants Connected to Public Supply.—SCHINDLER.—An article, illustrated by diagrams, showing the connections to be made, when the network of an isolated plant is to be connected for some hours to the public supply mains, especially in the case in which the three-wire system is used for the public supply, while in the isolated plant the two-wire system is used without an accumulator battery; also when the public supply uses the three-wire system and the isolated plant uses the three-wire system and has a battery.—*Elek. Anz.*, Apr. 15.

Twist Drill Company.—An illustrated description of the electric light and power equipment of the Cleveland Twist Drill Company's factory.—*Elec. Rev.*, May 9.

Light Fittings.—An illustrated description of the artistic electric light fittings at the London Hippodrome.—Lond. *Elec. Rev.*, Apr. 27.

WIRES, WIRING AND CONDUITS.

Wiring on Shipboard.—ADAMS.—An article discussing the relative merits of the one and of the two-wire systems of electric distribution on shipboard. The advantage of the one-wire system with steel hull return is a saving in both materials, especially copper for the line and labor; but the factors of mechanical strength, ampere carrying capacity and the uncertain increasing resistance of joints, make it impracticable to reduce the wires of a one-wire system below the sizes that would be used in the corresponding half of a two-wire plant; the saving of labor is not so great as might be supposed, since twin-wire cable is not much harder to erect than a single wire. There are, however, decided disadvantages of the one-wire system. Whether electrolysis at the joints between the steel plates of a ship's hull will ever become of importance is as yet an open question, but a practical demonstration of such effects may prove an expensive lesson. There is also a liability of loose joints becoming a serious danger as fire risks, and also a greater liability of electric shocks.—*Marine Eng.*; reprinted in *Elec. Rev.*, May 9.

House Wiring.—WALKER.—The first part of an article on the protection of insulated wires for electric light and power, inside of buildings. The way to provide a certain definite life, say 10 years, for the insulation of internal wires, is to use a substance, such as vulcanized rubber, protected from the wire by a layer of pure rubber, whose properties and whose rate of deterioration are known, and to provide a sufficient thickness to allow for a life of 12 or 13 years, when exposed to the current and to the operation of natural forces. Wood casing for protecting the wires has two serious faults; it is very difficult to arrange neatly, and the wood behaves like a sponge and absorbs a quantity of moisture, which assists the process of deterioration and assists the leakage current by lowering the resistance of the leakage path.—Lond. *Elec. Rev.*, May 4.

Aluminium Wires.—EHNERT.—An article in which he calculates the necessary cross-section of aluminium wires for a given rise of temperature and a given drop of voltage. He finds that the weight of aluminium wires for long distance transmissions is about half that of copper wires for the same drop of voltage; aluminium wires are then cheaper by about 23.5 per cent than copper wires. For short lines, the cross-section of which is to be determined under consideration of the rise of temperature, aluminium wires are lighter by 58 per cent and cheaper by 30.6 per cent than copper wires. The poles are also cheaper for aluminium wires on account of the smaller weight.—*Elek. Anz.*, Apr. 15.

Matthiessen's Standard of Copper Constants.—Communications by Everett and by Howard, and an editorial note on some figures in the report of the committee on copper conductors (Digest, Jan. 13). It appears that some figures given there, are not Matthiessen's actual figures, but were chosen as they were in best accord with present conditions. "The committee were engaged in fixing a commercial standard, and not in accurate scientific research."—Lond. *Elec.*, May 4.

ELECTRO-PHYSICS AND MAGNETISM.

Magnetized Coherers.—TISSOT.—A French Academy note describing a device which considerably increases the sensitiveness of the

nickel or steel coherer and at the same time makes it work with greater regularity and certainty. The device consists in placing the coherer in a magnetic field whose lines of force are parallel to the axis of the tube which contains some kind of magnetic filings, steel, nickel or cobalt. The electrodes should preferably be laminated and the tube may be placed between the pole pieces of an electromagnet; both the current traversing the coherer and the magnetic field controlling it, should be feeble. He succeeded in exchanging signals with a warship over a distance of 18 nautical miles with signaling masts only a hundred feet high. The action of the magnetic field appears to be purely mechanical.—*Comptes Rendus,* Apr. 2; abstracted in London. *Elec.,* May 4.

Electric Waves.—GUTTON.—An account of experiments made to examine whether electromagnetic waves when propogated through a medium whose electric constant is different from unity, have the same velocity when they are propogated freely through it and when they are guided by a wire. He found the speed of propogation independent of the presence of the wire. He measured the refractive index of bitumen for Hertzian waves; compared with air it is about 1.88.—*Comptes Rendus,* Apr. 2; abstracted in Lond. *Elec.,* May 4.

Actinium.—DEBIERNE.—A French Academy note in which he states that by treating pitch blende with reagents used for the extraction of metals of the iron group and more especially of titanium and thorium, he has succeeded in discovering a new radioactive substance which he calls actinium and which has the general characteristics of thorium. He suggests that the fact that the salts of thorium are feebly radioactive, may be explained to be due to traces of actinium, and that the latter is in fact the active principle of thorium radiation.—*Comptes Rendus,* Apr. 20; abstracted in Lond. *Elec.,* May 4.

Photographing Electric Lines of Force.—SCHAFFERS.—A French Academy note describing a method of obtaining photographs of electric lines of force in full daylight by the action of the secondary circuit of an induction coil upon a sensitive plate. Two needles form the terminals of the circuit, the positive being placed in contact with the sensitive film of a silver bromide or lactate plate and the negative being held about half a millimeter above the surface. The lines of force begin to trace themselves by a great number of small black lines, resembling arrows, which point from the positive to the negative pole, and which under the microscope resolve themselves into a mass of ramifications.—*Comptes Rendus,* Apr. 2; abstracted in Lond. *Elec.,* May 4.

Dynamical Theory of Heat and Light.—LORD KELVIN.—An abstract of a discourse delivered at the Royal Institution on "nineteenth century clouds over the dynamical theory of heat and light." The first cloud consists in the difficulty of conceiving how, if the ether be supposed to be an elastic solid, the earth and other bodies can move so freely through it. The second cloud lies in the Maxwell-Boltzmann doctrine of the partition of kinetic energy, which he does not consider to be true. He brought forward some considerations respecting the structure of the atom and the ether, pointing out that the ether must be truly imponderable and quite outside of the law of universal gravitation.—Lond. *Elec.,* May 4.

REFERENCE.

Electrographs.—GATES.—Reproductions of photographs obtained by placing a sensitive plate in a lightproof envelope and subjecting it to the action of a 10-in. spark from a static machine; also by placing a sensitized film between shellacked surfaces of glass; the latter show a peculiar stratification.—*Amer. Inventor*; three illustrations are reproduced in Lond *Elec. Eng.,* April 27.

ELECTRO-CHEMISTRY AND BATTERIES.

Solution Pressure.—MILNER.—A theoretical note on Nernst's theory of solution pressure, referring to Lehfeldt's criticism (Digest Oct. 14). He criticizes the more general thermodynamical methods by which Nernst's formula for the potential difference between a dilute solution and a reversible electrode has been developed by several authors, and describes the single steps of a complete cyclical process by which this formula may be concluded from the second law of thermodynamics. He shows that this formula depends for its validity only on the osmotic pressure and dissociation theory, and on the reversibility of the electrolytic solution and deposition of the metal at the electrode. It is independent of the nature of any special theory of the formation of the potential step at the electrode, so long as it admits of this reversibility. "On the other hand, it is very difficult to imagine a reversible equilibrium at the surface of the electrode which shall not be a dynamical one like all other chemical equilibria, that is, an equilibrium consisting in irons going into solution from the metal, and being deposited from the solution onto the metal at equal rates; and this in itself is Nernst's theory of solution pressure." The constant in Nernst's formula called solution pressure represents a solution pressure only in a range of concentrations for which the gas law is applicable; otherwise, as in the case of zinc, quoted by Lehfeldt, "it seems reasonable to put down the discrepancy to the failure of the gas law over the necessarily great range" between the osmotic pressure of the electrolyte and that constant called the solution pressure of the electrode. In these cases that constant "could not be considered as more than a constant," having a meaning evident from the respective equations.—*Phil. Mag.,* May.

Elmore Process.—An article on this electrolytic process of manufacturing copper tubes, which is now in successful operation both in France and England, and which consists essentially in depositing the copper on a revolving mandrel and in hardening and compressing the deposit by means of agate edges pressing on the deposited copper, as already noticed several times in the Digest. The financial struggles which the process had to undergo before final recognition, since it had been invented 15 years ago, are described. Details of the process are not given, "for the directors maintain strict secrecy, and all employees are expressly forbidden from writing or speaking of the process. There is a long series of patents on the subject, but the main patents have not long to run. The process depends very largely on delicate manipulation; in fact, it may be well described as a laboratory process on a large scale."—*Eng. and Min. Jour.,* May 5.

Electrolytic Tests of Copper.—GRAINGER.—An article describing the electrolytic method for estimating copper, used in all important cases in the laboratory of the Ducktown Sulphur, Copper and Iron Company; the calorimetric and the cyanide methods are used merely in furnace control work. There is apparatus for making 10 electrolytic determinations at one time, consisting of 10 coils of platinum wire, as anodes, and 10 platinum cylinders, as cathodes, supported by an insulated rack in such a way that one cathode and one anode may be placed in each solution to be electrolyzed. The dissolving of the samples is often difficult; if they are put through an 80-mesh sieve and then given a long treatment with aqua regia, all the copper will be dissolved out. A very important point is to keep the volume of the solution small. Detailed instructions are given.—*Eng. and Min. Jour.,* May 12.

REFERENCE.

Davy.—DEWAR.—An abstract of the first of a series of lectures on a century of chemistry at the Royal Institution, dealing with the work of Davy, especially in connection with the Voltaic cell.—Lond. *Elec.,* May 4.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Magnetic Tests of Iron.—ARMAGNAT.—A long, illustrated critical summary of the different methods of determining the magnetic properties of iron. There is a certain relation between the ductility and the magnetic properties of iron; the more it is ductile, the greater is the permeability, and the smaller the hysteresis loss, the chemical composition being assumed to be the same. Whenever the ductility is modified, the magnetic properties are also modified: Hammer-hardening diminishes the permeability and increases the hysteresis loss, while annealing has the reverse effect. To make magnetic measurements of some value, it is necessary to use the iron in a well-defined physical condition; we do not know any other means than to carefully anneal the samples for the tests. They are to be annealed whenever they have been subjcted to any mechanical strains which are apt to harden them, as punching, turning, etc., or if it is desired to nullify the effects of preceding magnetizations. Independently of these precautions, care must be taken not to subject the samples during the measurements to any mechanical effect, such as pressure, stretching or torsion. Different parts of the bar or sheet of iron always show small differences in their chemical composition and great magnetic differences; the magnetic properties vary even at the same point, with the direction, the permeability of laminated iron being different in the direction of the lamination and in the direction perpendicular to it. Annealing often diminishes these differences, but does not abolish them. Five methods of measuring the permeability are discussed: (1) the magnetometer method, which is apparently the simplest and requires the least apparatus; it is very delicate and requires conditions which are scarcely found in industrial practice; it is necessary to use very long iron bars, the length being about 300 to 500 times the diameter. (2) The induction method, which is

much more convenient, especially since ballistic galvanometers with a moveable frame have come into more general use; it is also the most exact method, but it is necessary to take certain precautions without which the results lose their absolute value. Iron bars of very great length or rings or iron, are required to get accurate results. The method of Hopkinson is criticized and it is shown that errors above 30 per cent may occur; it is, however, possible to get better results by obtaining a curve of correction for the apparatus used, which method is often used with graduated apparatus and may be applied to Hopkinson's apparatus. The method of Ewing is described, for measuring the permeability of an iron bar of not too great length; it is, however too long for practical use, as it requires too accurate measurements for the same value of magnetic induction, but it may be used for careful tests of a bar which is to be applied later either for the determination of the correction of an apparatus of Hopkinson or for graduating an apparatus for direct readings; the results are very accurate, if it is possible to get iron bars which are very homogeneous, but these are scarce. (3) The method of tractive force, used in apparatus of S. P. Thompson, Dubois and Ewing; the permeameter of S. P. Thompson is very simple in practice, but very inaccurate. (4) The method of comparison; the magnetic bridge of Ewing is in practical use and enables comparisons of sufficient accuracy to be made; but its application is somewhat tedious. (5) Air-gap apparatus, in which the value of the magnetic induction in the sample bar is found by determining the field generated in a small air gap of a cross-section equal to or greater than that of the bar. The apparatus is to be graduated by comparison, by means of a sample previously tested, and a curve of correction is necessary for taking into account the reluctance of the iron and the air gap. The apparatus of Bruger, Koepsel and Kennelly, Siemens and Halske, and Ewing, are very briefly described. It is said that very probably in this class of apparatus really practical instruments may be found which may be used by persons not accustomed to careful laboratory experiments, and that the instruments which exist so far, already offer great advantages in this respect. Hysteresis losses may be studied either by generating an alternating magnetic field in a fixed iron core, or by revolving an iron core in a constant magnetic field; the former he calls alternating hysteresis, the latter revolving hysteresis, the latter being somewhat greater than the former. The practicability of the use of Steinmetz's coefficient of hysteresis is pointed out and the following three methods of measuring hysteresis losses are discussed: (1) The ballistic method is the classical method and is capable of giving the greatest accuracy; it requires too much time for practical use, but is well adapted to the tests of samples which are then to be used for graduating other instruments. (2) The wattmeter method also requires much time and is delicate; its results are also uncertain on account of the fact that it is difficult to determine to which maximum magnetic induction the tested iron has been subjected; as the exact wave form of the used alternating current is nearly always unknown, it is necessary to make as an uncertain hypothesis on the relation between the maximum value and the effective value, which is measured; but this objection is of no importance for more qualitative measurements in practice. (3) Hysteresis meters which he considers to be best adapted for practice. The two best known types, that of Ewing and that of Blondel, allow numerous and quick measurements. Both types must always give different results, as the former measures the alternating hysteresis loss, the latter the revolving hysteresis loss. Besides, measurements with the instrument of Ewing are somewhat uncertain on account of lack of proportionality between hysteresis and deviation. While there is agreement between the hysteresis measurements of iron of high hysteresis loss, made with the ballistic method and with hysteresis meters, for iron with small hysteresis loss the instrument of Ewing sometimes gives results which disagree.—*L'Ind. Elec.*, Apr. 25.

Wehnelt Interrupter.—Ruhmer.—An illustrated article referring to the article of West (anaylsis of spark discharge, Digest, Nov. 18, where the name of the author, West, was omitted by mistake). West had found by mutographical images of spark discharges of an induction coil operated by a Wehnelt interrupter, that the action of the latter is not quite regular. Wehnelt replied that the irregularity may be due to the spark gap of the induction coil. The present author made mutographical images of the breaking spark in the interrupter itself, and found West's results to be correct. There is a certain irregularity in the action of the Wehnelt interrupter, also in that of the Caldwell-Simon interrupter, the latter being, however, more regular than the former.—*Elek. Zeit.*, Apr. 26.

REFERENCES.

Indicating Wattmeter.—An illustrated description of the Thomson-Houston indicating wattmeter for incandescent lamp testing, which is used in connection with a photometer for determining the watts per candle. The wattmeter is of the Thomson inclined-coil type.—Lond. *Elec. Eng.*, May 4.

Direct-Reading Potentiometer.—An illustrated description of an instrument the chief points of which are the quality of direct reading and the substitution of a short length of slide wire, practically answering the purpose of a vernier, for the long wire originally in vogue.—Lond. *Elec. Rev.*, May 4.

Telegraphy, Telephony and Signals.

REFERENCE.

Cable Steamer Podbielski.—Jamieson.—The first part of an illustrated description of this steamer, noticed in the Digest, Dec. 9, 30. Lond. *Elec. Rev.*, May 4.

Miscellaneous.

Lightning Rods.—A report of a special committee of the Electrotechnical Society of Berlin, signed by K. Streeker. The first intention of giving special detailed rules for the construction of lightning rods, had to be abandoned, as there was great disagreement concerning some details; therefore only those of the more general principles were given in the report, concerning which there was no disagreement. The report consisted of resolutions which will be voted on at the next meeting of that society. The work of Findeisen is very favorably commented upon. The report emphasizes the fact that a lightning rod really affords protection; its use should be more extended by simplifying and cheapening its construction; the installation of lightning rods should be considered in the design of a building, not after it has been erected. The lightning rod consists of three parts: the upper part for receiving the flash, the line, and the connection to earth; the top consists of metallic points, surfaces or edges, of any form, not necessarily in form of a rod with a geometrical point; the line should connect the upper part with the earth conductors by the shortest possible path, and with the fewest possible bends; it should surround the building, especially the roof, if possible, on all sides; the metallic portions of the building, such as the gutters, drain pipes, etc., may be used for the line; the line is to be connected with all large metallic masses on the building; the earth conductors should be as extended as possible; damp places, should be favored; existing metallic pipes may be used and may be considered as a sufficiently good ground. The prevention against damage by flash is the greater, the more all parts of the building which are liable to flashes are protected by metallic collectors, the greater the number of lines along the building, and the more extended the earth conductors. Even a defective lightning rod may give protection; an increase of the danger can result only from very great and unusual mistakes in its installation. Branched lines of iron should have a cross-section of at least 50 mm^2, unbranched lines of at least 100 mm^2; for copper, half of these cross-sections are sufficient; zinc should have a cross-section of 1½ times that of iron; lead 3 times that of iron. The single parts of the line may be connected by soldering, riveting, screwing, etc.; connections which are not soldered should be at least 10 cm long. In order to keep the lightning rod in good condition, tests by experts are necessary from time to time.—*Elek. Zeit.*, Apr. 26.

Electromagnets for Removing Iron Pieces.—A note describing an instance of the utility of the electromagnet for removing pieces of iron and steel from very awkward places. In a German mine a drill was being sunk, and at a depth of almost 1000 feet the hardened end of the steel bit broke off. A soft iron bar 5 ft. long and 2.7 in. in diameter, was surrounded by a single winding of india-rubber-covered wire and let down the hole; when at the bottom, current was switched on, and by the electromagnet the steel end was raised to the surface without further trouble.—Lond. *Elec. Eng.*, May 4.

REFERENCES.

Metal Market.—Diagrams showing the fluctuations of the price of zinc, lead, iron, tin, and copper during April.—Lond. *Elec. Rev.*, May 4.

Educational.—An illustrated article on electrical engineering at the Purdue University in Lafayette, Ind.—*Elec. Rev.*, May 9.

New Books.

THE GAS-ENGINE HANDBOOK. A Manual of Useful Information for the Designer and Engineer. By E. W. Roberts. Cincinnati: The Gas Engine Publishing Company. 220 pages, 184 illustrations. Price, $1.00.

This book is a welcome contribution to the existing literature on gas engines. There are very few good works on this subject, and many of them are so replete with mathematical discussion as to be beyond the practical man. The book by Mr. Roberts comprises in all twenty-five chapters. These discuss in detail the principle of internal combustion engines, the various types, the fuels and their heating values, and several chapters are devoted to the operation and care of gas and gasolene engines. Following these are what appear to be a very thorough series of chapters describing the parts of internal combustion engines and the various mechanisms employed. Next in order are a series of chapters which will be of great assistance to any designer in the building and designing of a gas engine. The work is replete with formulas and drawings which will enable the draughtsman to dimension every part of an internal combustion engine. There is also included in the work a chapter on testing which describes all the necessary operations for a gas engine test for any purpose, and gives rules for working up the data obtained. The work is supplemented by a chapter on the selection of a gas engine and tabular data much used by designers, and a complete index is appended.

The book is not a large one, and cannot therefore cover the field exhaustively, but it comprises the points which the gas engine novice is anxious to learn, and is very convenient as a handbook of reference to a draughtsman employed on gas engine work. It can be thoroughly understood by any one having a knowledge of simple equations in algebra, but the greater part of the work is not mathematical and can be intelligently read by those who have only an arithmetical education. The book is not a compilation of trade catalogues and descriptive matter, but is devoted to genuine and useful engineering information.

FLAME, ELECTRICITY AND THE CAMERA. Man's Progress from the First Kindling of Fire to the Wireless Telegraph and the Photography of Color. By George Iles. New York: Doubleday & McClure Company. 398 pages, 115 illustrations. Price, $2.00.

This volume is devoted, as the title indicates, to a description of the uses of fire, electricity and photography. Beginning with primitive man, the author traces the chief uses of fire to the present day, through ages of wearing and uncertain experiment, and shows how it has been supplemented and to a large extent supplanted by electricity, the crowning achievement of the nineteenth century, and especially of the last three decades. "Of the strides taken by humanity," says the author, "on its way to the summit of terrestrial life, there are but four worthy of mention as preparing the way for the victories of the electrician—the attainment of the upright attitude, the intentional kindling of fire, the maturing of emotional cries to articulate speech, and the invention of written symbols for speech. As we examine electricity in its fruitage we shall find that it bears the unfailing mark of every other decisive factor of human advance; its mastery is no mere addition to the resources of the race, but a multiplier of them."

In the first part of the work the principal methods of kindling fire and its uses in cookery, pottery, chemistry, metallurgy, engineering, as well as its place in religious rites and in myth, are discussed. Then follows a comprehensive exposition of the manifold applications of electricity, the pre-eminence of this force as a producer of energy, a means of communication, and as a social benefactor being well brought out. The final chapters are given up to the consideration of photography, the discovery of which the author regards as ranking second in importance among the scientific feats of the nineteenth century, that of electricity being the first.

The book is both well written and instructive, and to be commended to the reader not alone because of the inherent interest of the subject-matter, but also on account of the philosophical spirit that characterizes its presentment. As a specimen of book-making it leaves nothing to be desired, the paper, type and illustrations being excellent.

BOOK RECEIVED.

MACHINISTS' AND DRAUGHTSMEN'S HANDBOOK. Containing Tables, Rules and Formulas, with Numerous Examples. By Peder Lobben. New York: D. Van Nostrand Company. 438 pages, — illustrations. Price, $2.50.

Directory of Electrical Societies, Etc.

NEW YORK ELECTRICAL SOCIETY. Next meeting, Power House Metropolitan Street Railway Company, Ninty-sixth Street and First Avenue, Friday evening, May 25. Addresses by Messrs. Arthur Mann and William A. Low.

NORTHWESTERN ELECTRICAL ASSOCIATION. Next meeting, Waupaca, Wis., June 26, 27 and 28, 1900.

CANADIAN ELECTRICAL ASSOCIATION. Next meeting place and date to be announced later.

AMERICAN STREET RAILWAY ASSOCIATION. Next meeting, Kansas City, Mo., Oct. 16, 17, 18 and 19, 1900.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Next meeting, Chicago, May 22, 23 and 24, 1900.

NATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Next meeting, Pittsburg, Pa., Sept. 25, 26 and 27, 1900.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Next meeting, New York, Sept. 25, 26 and 27, 1900.

INDEPENDENT TELEPHONE ASSOCIATION, Cleveland, Ohio, June 12-14, 1900.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, New York, June 20, 1900.

The Methods of Automobile Manufacture.

THE growth of the demand, and of the resulting manufacturing facilities for automobile vehicles during the last three years has been almost without parallel in the history of industrial development. The illustrations which accompany this article give a few views, both of interiors and exteriors of the factories of the Columbia & Electric Vehicle Company, of Hartford, Conn., whose

FIG. I.—BODY SHOP, NEW HAVEN FACTORY.

product is sold through the Electric Vehicle Company, of New York City. Besides the main works, the Hartford Company occupies the plant formerly used by the Hartford Cycle Company for the manufacture of bicycles, and has also acquired the New Haven Carriage Company, of New Haven, where a large proportion of the bodies for its automobiles are made. In all, this company now occupies for manufacturing 9.2 acres of floor space, and employs 1500 men.

To a very great extent carriage methods of construction have been followed in building the Columbia automobiles. The panels of the vehicles are made of white wood, and those portions upon which the body depends for strength and rigidity are built of oak, securely tenoned and mortised together. The frames are further reinforced where required by wrought iron braces. The group of illustrations, Figs. 1, 2, 3 and 4, give an idea of the facilities and methods of construction employed.

The iron work on the carriage bodies, including the braces, spring supports, steps and similar comparatively small and intricate work, is done very largely by hand, and Fig. 5 shows the forge shop where this class of ironing on the vehicles is done. The blast for the forges is taken from a pipe in which pressure is maintained by means of a blower.

The heavier iron work, however, which includes such forgings as the front axles and pivot brackets, is carried on in the forge

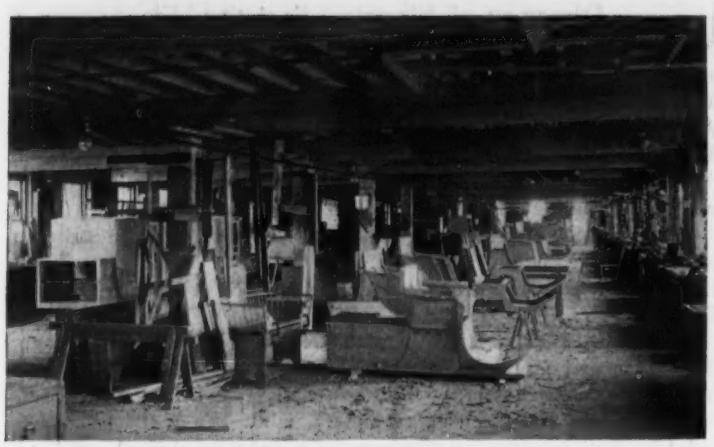


FIG. 2.—BODY SHOP, NEW HAVEN FACTORY.

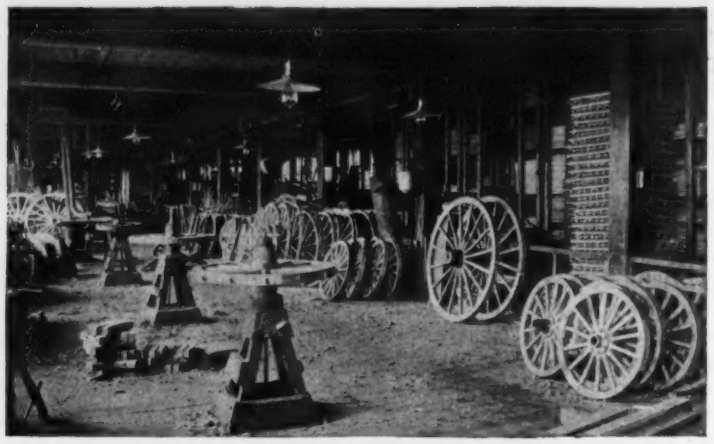


FIG. 6.—WHEEL ROOM, NEW HAVEN FACTORY.

FIG. 3.—ASSEMBLING ROOM A, MAIN WORKS, HARTFORD.

FIG. 7.—MAIN WORKS, HARTFORD.

FIG. 4.—ASSEMBLING ROOM, EAST WORKS, HARTFORD.

FIG. 8.—ASSEMBLING ROOM, MAIN WORKS, HARTFORD.

FIG. 5.—FORGE SHOP, NEW HAVEN FACTORY.

FIG. 9.—INTERIOR OF MAIN WORKS, POWER FORGE SHOPS A.

shop in Hartford, illustrated in Fig. 9. Here there is a complete equipment of trip hammers and drop hammers, as well as the latest types of blast furnaces. The work is done in dies under the drop or trip hammers, and the equipment of the shop for this work is of the most modern type.

The wheel room, shown in Fig. 6, employs the usual methods of wagon construction, but the product has the added strength necessary for automobile work. For all except the lighter classes of vehicles, the company has abandoned wire wheels, and uses wooden wheels with wooden or iron hubs, made at the New Haven factory.

The wagon bodies are shipped to Hartford unvarnished, the wheels being without tires. At Hartford bodies are fitted with springs, running gear, steering mechanism and motors, and the tires are placed on the wheels; the controllers are installed, the body is wired, and after a thorough test each vehicle is painted, varnished and shipped. Figs. 3, 4, 7 and 8 show different departments in which this work is done, and give an idea of the scale on which it is being carried. The principal output of the company consists of hansom cabs, straight front and extension front, broughams, physicians' broughams, delivery wagons, omnibuses, wagonettes, phaetons with tops, runabouts and victorias, all of the electric variety. It also manufactures gasolene delivery wagons and runabouts.

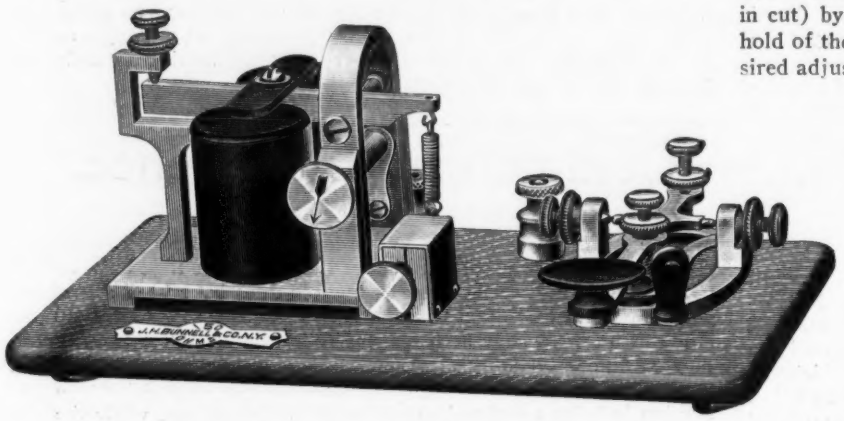
It is an excellent commentary on the growth of the electric automobile business to note that the facilities illustrated in these cuts are crowded to their utmost capacity, and at present there is not even a department of the Columbia works for the storage of finished vehicles. The product is shipped as fast as it is ready.

To sum up, the manufacture of the Columbia vehicles is divided into departments, as follows: The wagon body department and the wheel department produce their output entirely from the raw material, and most of this work is done at the New Haven factory. The running gear, which includes the gearing of the motor to the driving shaft on to the wheels, the compensating gear, the pivoted hubs, the steering mechanism, are all produced from the raw material at the Hartford factory; here also controllers are designed and made. The motors are largely purchased from the leading manufacturers of electrical machinery, and the springs are purchased from manufacturers who make these a specialty, and it is probable that no automobile concern will ever make its own springs, because their manufacture is an art in itself, and it would be comparatively difficult for any manufacturing concern to produce springs as cheaply as they can be bought. The assembling, painting, finishing and varnishing are done at Hartford.

At present the storage batteries are purchased in the market. The Columbia people have experimented with practically every type that has been produced to date. They now use the product of the Electric Storage Battery Company, of Philadelphia, and some of the latest types they have brought out, designed and adapted especially for vehicle use, present some remarkable developments in the way of mileage capacity and durability.

It will be interesting to follow the course of automobile construction. The street railway has developed a number of distinct manufacturing interests in its business. One company makes trucks, another car bodies, another controllers, motors and generators, and still another overhead line material, and another rails. It is stated that there is no one company in the United States that makes everything necessary for a trolley road, or even a complete trolley car. It is, therefore, an interesting production problem to see if any one company will succeed in economically producing everything necessary for the manufacture of a complete automobile, or whether the work will be divided among specialists, as the electric railway industry has been.

Up to the present time, almost the entire output of the Columbia & Electric Vehicle Company has consisted of electric vehicles. In this country the electric automobile was the first to prove its claim for consideration on the score of convenience, economy and other desirable features. Further, it is generally conceded that the electric vehicle in urban service, or for use where the mileage limitations of storage batteries need not be considered, has no rival. In this field it is not probable that either gasolene or steam vehicles can trespass. It has been recognized, however, from the first by the Columbia Company that for other work other types of vehicles are needed. Its gasolene delivery tricycle for the transportation of light merchandise, and its gasolene runabout, bid fair to achieve as great success for their particular work as its electric vehicles have had.



MAIN LINE SOUNDER.

New Main Line Sounder.

An improved type of main line sounder containing several new and desirable features has been brought out by J. H. Bunnell & Co., 20 Park Place, New York. A notable point of novelty is the instantaneous adjustment of the distance between the armature and the magnet cores, which is accomplished by an eccentric movement operated by the upper adjusting nut, causing the arch in which the armature is pivoted to slide up or down in its guides. The arrow on the adjusting nut indicates at a glance the relative position of armature to magnet. The adjusting nut is also provided with a projection (not shown in cut) by means of which the operator can tell as soon as he takes hold of the adjusting nut which way to move in order to get the desired adjustment.

CEILING FAN.

It will be noticed that the screw and the check nut that are ordinarily used on the front end of the armature lever, have been dispensed with, simply a steel pin being inserted in lower side of the lever to strike the anvil. When the indicating arrow on the adjusting nut points straight downwards, the armature is as close as possible to the magnet cores, but they can never come into actual contact.

One of the annoyances of the old form of main line sounder or relay, was the breaking of the string used to vary the tension of the retractile spring of the armature. In the new form the use of string or cord is entirely dispensed with, and a long, quick range of adjustment is secured by means of a cam lever operated by the lower adjusting nut. It will be observed that both adjustments are operated from the front of the instrument, thus making it more convenient to adjust, whether mounted in combination with a key on same base or separately on table or in resonator box.

Bates Electric Fans.

The illustration above gives a view of the ceiling fan manufactured by Messrs. D. L. Bates & Bro., Dayton, Ohio. Various improvements have been made in these fans, both in their mechanical construction and in their efficiency, and the manufacturers claim that they are equal to any machine of like character on the market at the present time. The firm manufactures fans of the ceiling, column, desk and wall bracket types, with and without switch and electrolier attachment. The fans are wound for direct current, of any voltage up to 500, and are finished in the usual styles. This firm also manufactures 16-in. and 18-in. water-motor fans, for which there is a large demand.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Call money was quoted at 1½@2½, with an easy tendency at the close of the week. Time money was quoted at 3 per cent for 60 to 90 days and 3½ per cent for longer periods. Mercantile paper was dull, the rates being 3½@3¾ per cent for indorsed bills receivable. The weekly statement of averages of the Associated Banks shows an increase in lawful money of $1,556,000. The banks have increased their loans only about $750,000 and, in consequence of these two changes, the deposits are not materially larger than they were a week ago. The net result is, therefore, an increase of 1¼ millions in the surplus reserve. In the stock market the notable feature was a narrow and irregular speculation. A comparatively limited number of stocks furnished most of the activity and interest in the week's dealings. The gas stocks became strong on the announcement of the settlement of the gas war in New York. Early in the week the traction stocks were depressed, but gained strength later in the week when the ratification of the Third Avenue lease brought inside support in Metropolitan. Brooklyn Rapid Transit closed at 70⅞, a net gain of ¼ point as compared with the closing price the previous week; the transactions aggregated 7510 shares. General Electric was extremely quiet, the sales being only 100 shares, and the quotations during the week being practically steady, at 135. Metropolitan Street Railway closed at 154¾, a net gain of 1½. The highest point reached was 156; the sales were 3270 shares. Two hundred shares of Third Avenue were sold, the range of prices for the week being between 109 and 110, the former being the closing quotation, which represented a net gain of ½ point. Western Union Telegraph closed with a net gain of 1 point, the closing quotation being 81. The sales were 677 shares. Among the inactive stocks American Cable is quoted at 88 and Commercial Cable 160. Outside securities in general exhibited a tone somewhat stronger than that prevailing for several weeks past, and some advances are noted. With the single exception of Electric Boat common, which sold up about 6 points and ended the week with a net gain of 3 points, the electric stocks were dull and somewhat weak. Electric Vehicle, notwithstanding a favorable statement by an officer of the company in regard to the development of the company's business, sold down to 25, the lowest figure at which the stock has sold since the beginning of last year. It closed at 25 bid, a net loss for the week of 2 points. The preferred stock was also offered lower, at 76. The closing quotations of outside securities are as follows: Electric Boat common, 20; do. pfd., 40; Electric Vehicle, 26; do. pfd., 79 asked; General Carriage, 7½; Ills. Transp., 1¼; New England Transp., 4¼; New York Elec. Vehicle Transp., 8; N. Y. & N. J. Telephone, 166; Telephone, Telegraph & Cable of America, second assessment paid, 4½. The closing quotations in Boston were: American Bell Telephone, 312; Erie Telephone, 101; Westinghouse Electric, 48 asked; General Electric pfd., 137. In Philadelphia Electric Stor. Bat. common closed at 85; do. pfd., 89 asked.

THE METROPOLITAN-THIRD AVENUE LEASE.—A special meeting of the stockholders of the Metropolitan Street Railway Company was held on May 17, at which it was voted to lease the Third Avenue Railroad Company's property for 999 years and also to increase the Metropolitan Company's capital stock from $45,000,000 to $52,000,000. The amount of Metropolitan stock now outstanding is 446,000 shares. The value of the stock voted was $33,900,000 and the votes in favor of the lease and the increase of capital stock were both unanimous. President Vreeland made a long statement to the stockholders relative to the recent development of the Metropolitan system and its future plans and prospects. The increase in Metropolitan's capital, he said, was for the purpose of continuing and completing improvements already in progress, the most important of which is the conversion of 23 miles of cable traction into underground electric. "The economy which this change of traction will effect will more than pay the interest at 7 per cen on the increased capitalization," he said. "The average cost of operating our electric lines per car-mile," he stated, "is 12.91 cents. The average cost of cable traction is 17.99 cents." A special meeting of the stockholders of the Third Avenue Railroad Company was held on the same day to ratify the lease by which the company was to become a part of the Metropolitan system. Mr. Edward Lauterbach, counsel of the company, announced later that the lease had been ratified without dissent.

ERIE TELEPHONE DEBENTURES.—Following the provisions of the indenture of Jan. 1, 1900, whereby the directors of the Erie Telephone Company pledged themselves to secure the $5,000,000 bonds due 1928 and 1929, the board has formally entered into an indenture with the Old Colony Trust Company, trustee, by which shares of the Northwestern Telephone Exchange Company, the Southwestern Telegraph & Telephone Company, the Cleveland Telephone Company, the Michigan Telephone Company and the Wisconsin Telephone Company, amounting in par value to $5,000,000, will be deposited with the said trust company as collateral to the bonds in question. In this connection Messrs. H. W. Poor & Co., have sold to a syndicate of New York and Philadelphia bankers the balance of $2,000,000 of said debentures. These bonds are to be listed on the New York and Philadelphia Stock Exchanges.

DIVIDENDS.—The National Tube Company has declared dividends of 1½ per cent on its common stock and a quarterly dividend of 1¾ per cent on its preferred stock. The former dividend is payable on Aug. 15 and the latter on July 2. The Kings County Electric Light & Power Company has declared its first quarterly dividend of 1½ per cent, payable June 1. Reports read at the directors' meeting showed that the earnings amounted to 12 per cent of the capital stock, of which there is $2,000,000 issued.

THE TWIN CITY RAPID TRANSIT RAILROAD, St. Paul, Minn., reports gross earnings for April of $215,791, an increase of $25,452 as compared with the same month of last year and net $107,881, an increase of $11,265. For the four months ending April 30 the gross earnings were $861,467, an increase of $110,674 as compared with the corresponding period of last year and net $428,739, an increase of $51,651. Fixed charges were $285,790, leaving a surplus of $142,949, an increase of $35,951.

Commercial Intelligence.

THE WEEK IN TRADE.—The industrial situation, Bradstreet's reports, is on the whole rather better than for some time past, in that new disturbances are fewer and some old ones have been settled up, but the practical tie-up at Chicago is still unbroken. At St. Louis all kinds of business have been hurt by the strike of street railway employees and uncertainty at other cities, particularly in the building trades, has had an unsettling effect upon lumber. Anthracite coal production is being restricted to seasonable requirements, while the settlement of bituminous trade labor matters is regarded as favoring continued good trade. The iron and steel situation is no stronger and shaded prices failed to develop much new business. The gross earnings of 142 roads for the first quarter of the calendar year, according to the same authority, were $268,700,047, with net returns of $81,215,970, an increase of 15.4 per cent as to gross and of nearly 22 per cent as to net, this being explained largely by improved weather and trade conditions this year as compared with a year ago. The business failures for the week numbered 155, as compared with 174 the week previous, and 168 in this week a year ago. The metal market remains quiet and unchanged. Copper, Lake Superior ingot is still quoted at 16⅞ cents; electrolytic, 16¾@16⅞ cents, and casting, 16¾ cents.

EXPORTS OF ELECTRICAL MATERIAL.—The following were the exports of electrical material from the port of New York for the week ended May 19: Argentine Republic—33 cases electrical machinery, $2,216; 180 packages electrical material, $7,973; 18 cases electrical motors, $2,625. Antwerp—31 cases electrical material, $3,203. Brazil—124 cases electrical material, $3,542; 12 packages electrical machinery, $756. Bristol—114 cases electrical machinery, $11,139. British Guiana—21 packages electrical material, $867. British West Indies—10 cases electrical material, $146. Brussels—27 packages electrical material, $689. British possessions in Africa—45 packages electrical material, $2,627. British East Indies—23 packages electrical material, $481; 19 packages electrical machinery, $5,510. Barcelona—110 packages electrical material, $7,751. Central America—83 cases electrical material, $831. Chile—4 cases electrical material, $58. Cuba—96 packages electrical material, $4,023; 805 packages electrical machinery, $16,038. Dunkirk—2 packages electrical material, $375. Genoa—9 cases electrical material, $1,428. Glasgow—23 packages electrical material, $921. Havre—182 packages electrical material, $19,639; 2 cases electrical machinery, $634. Hamburg—50 cases electrical material, $4,800; 6 cases electrical machinery, $1,950. Ipswich—121 packages electrical material, $12,502. Liverpool—48 packages electrical material, $2,778. London—166

packages electrical machinery, $5,524; 61 packages electrical material, $3,517; 1 case electrical instruments, $880. Margate—112 packages electrical machinery, $21,127. Mexico—43 packages electrical material, $5,088; 9 packages electrical machinery, $1,050. Manchester—2 cases electrical material, $1,200. Marseilles—19 packages electrical material, $1,163. Peru—205 packages electrical material, $5,242. Philippines, 18 cases electrical machinery, $5,780; 1 case electrical material, $10. Rotterdam—4 cases electrical material, $69. Southampton—9 cases electrical material, $233. U. S. Colombia—9 packages electrical material, $92.

SOUTH AFRICAN TRADE.—Makers of electrical apparatus are fastening their attention on South Africa, as it seems probable now that there will be an early termination of the war, and of course the cessation of hostilities will mean a vigorous extension of improvements. The probabilities are that electricity will play a very important part in the development of South Africa in the near future. Electrical mining machinery will doubtlessly be in great demand, franchises will be asked for and granted, and work commenced on electric street railways, electric lighting plants and telephone exchanges in places which heretofore have not been blessed with these modern conveniences. Several companies have their representatives now in South Africa on the ground awaiting the signing of a peace treaty. German manufacturers are well represented there, and expect to have their full share of the business. Naturally the English manufacturers have the same hope, but if the American is sufficiently enterprising there is no question that this country will obtain a goodly portion of the business to be given out there.

STREET CAR TRUST.—It is reported from Philadelphia that negotiations are now pending which may result in the formation of a street car trust. Mr. George W. Alexander, of the American Car Company, St. Louis, Mo., was in Philadelphia last week, and in an interview is reported to have said that the question of the formation of a trust in street car construction seems to be favorably received by the big companies, after repeated failures by its promoters. Europe, Mr. Alexander said, has loomed up as a fallow field for American street cars, and if the trust is formed it is probable big car shops will be erected in England to supply the demands of the continent. The trust, he added, will wipe out the vicious and unprofitable competition between the various competitors for the European business as well as the business of Mexico and South America, while it will fix a price on cars for use in this country. The J. G. Brill Company, he said, has been asked to join the combine.

GENERAL MANAGER WM. A. McCALLUM, of the Electric Railway Equipment Company, reports the volume of business this year to date as comparing favorably with that for the same period last year, but at the present time there is not the same buoyancy as marked the same date of last year. "The decline in iron prices," said Manager McCallum, "has caused heavy buyers to hold back their orders for necessary requirements anticipating still further decline. As soon as it is realized that prices have reached bottom we anticipate heavy buying and believe that prices will stiffen to a reasonable degree, but not to such extravagant figures as those of last year." Mr. McCallum's company has made some heavy shipments within the past ten days to points in Massachusetts, New York, New Jersey, Indiana, Illinois, Mexico, Argentine and California. The company is figuring on several large specifications for work to be done in England this fall.

ELECTRIC LIGHTING PLANTS FOR THE FAR EAST.—The Bullock Electric Manufacturing Company, of Cincinnati, is about to export three electric light plants to out-of-the-way parts of the world. One will be utilized for supplying light in the offices of an American concern at Irkutsk, Siberia, which has recently secured concessions from the Russian and Chinese governments for the development of gold-bearing regions in Siberia and Manchuria. A direct-connected unit will be forwarded to the Siberian mines near Chita, where it will be used to furnish power for two searchlights—also to be supplied by the Bullock Company. These searchlights will be affixed on a Vivian steam scraper, which will work both day and night. Another plant intended for lighting dredgers, will be shipped to the Manchurian mines situated about 600 miles from Tiensin.

MINING MACHINERY IN SOUTH AFRICA.—Mr. J. M. Andrews, assistant general manager of the Power and Mining Department of the General Electric Company, while in Cincinnati last week at the convention of Mechanical Engineers, stated to a representative of the ELECTRICAL WORLD AND ENGINEER that mining operations in the South African field interrupted early in the year by the Boer-English war give evidence of early resumption; that orders are being placed and early shipments asked. Mr. Andrews believes that the operations in that field will be renewed with great vigor and that much valuable machinery is destined to be sent there by American firms. He stated that American concerns have now the entire field which was at one time monopolized completely by the British manufacturers.

ITALIAN DEMAND FOR AMERICAN MACHINE TOOLS.—An agency at 39 Cortlandt Street, New York, has been asked by Mr. Carlos Nafe, 31 Via A. Manzoni, Milan, Italy, a large dealer of machinery and tools, for quotations on an extensive quantity of machine tools of Western make. The addresses of Eastern manufacturers of machine tools, such as lathes, drills, presses, etc., are also requested. The demand for all kinds of labor-saving tools in Italy seems to be active, and a particular feature of the trade is that stock orders, which are always large, are sent several times a year.

RAILWAY APPARATUS.—The Staten Island Electric Railway Company is in the market for a 2000-hp engine for its new power station at Livingston, S. I. The company has purchased two 750-hp engines from the E. P. Allis Company, of Milwaukee, and ten 350-hp Aultman & Taylor water-tube boilers, and bids will be received on four additional water-tube boilers of 500 horse-power each. Automatic stokers for the entire equipment will also be purchased. Among other equipment to be purchased are a 1500-kw generator and a switchboard.

COPPER EXPORTS AND PRODUCTION.—The copper exports from Atlantic ports during the week ended May 11 were 2482 tons. Since May 1 the exports were 4906 tons. The total exports since Jan. 1 were 57,154 tons compared with 36,055 tons during the same period last year. The total production of copper (long tons) in the United States during April, this year, aggregated 24,067 tons, compared with 20,148 tons in March. The European production for April in long tons, aggregated 7325, compared with 7544 tons in March.

THE BOSTON WOODS MOTOR VEHICLE COMPANY has been formed with $300,000 capital to operate a public carriage service in Boston under the Woods patents. Among officers and directors are the following: Samuel L. Powers (president); H. W. Mason (treasurer); Chas. T. Gallagher, General Wm. A. Bancroft, M. O. Adams and E. D. Bangs. The company will conduct a selling business in addition to a cab and delivery service. A central station will be established on Eliot Street between Washington and Tremont.

ELECTRIC POWER IN STEEL WORKS.—The Carnegie Steel Company, of Pittsburg, has completed arrangements to change the motive power on its 30-in. structural beam mill from steam to electricity. The shifting tables of the rolls will be operated by electric motors instead of engines. The company introduced some time ago electric power in the 33-in. mill, which has proved a great saving of time and labor in the operation of that mill, and this no doubt caused the addition of this new equipment.

AMERICAN STEEL & WIRE COMPANY.—A despatch from Worcester, Mass., states that the wire rope department of the Washburn & Moen department of the American Steel & Wire Company is being enlarged by an addition to the Quinsigamond works. Nearly 6000 hands are employed at the Worcester works. A Dekalb, Ill., despatch reports that all departments of the American Steel & Wire Company's mills are reopened and running as usual with a double shift of men in nearly all of them.

APRIL EXPORTS.—The total exports in April, as announced by the Treasury Bureau of Statistics, are $118,926,507, which is $30,000,000 more than April of last year and double that of April, 1893. Never before has April, which is usually a light export month, reached the $100,000,000 mark in its exports. Every branch of industry lends its aid to this increase. The total figures for the month of April have not yet been sufficiently analyzed to show the exact increase in each class.

THE AMERICAN BRIDGE COMPANY.—It is reported here that the manufacturing headquarters of the American Bridge Company will be located in Pittsburg, where plants have an annual tonnage of 100,000 of the combine's annual total of 500,000 tons. Some also talk of Elmira, N. Y. It may be that the plan of dividing the country into three districts will be followed, eastern at New York, middle at Pittsburg, and western at Chicago.

RUSSIAN ELECTRICAL WORKS.—The Compagnie Centrale d'Electricite de Moscou is erecting a large plant for the manufacture of dynamos and other electrical apparatus at Moscow, Russia, its capital having been increased to two million dollars in order to extend the present plant. It will employ some 1200 men, and expects to be ready for operations in about three months.

THE FEDERAL WIRE COMPANY has been incorporated at Waterville, Me., to manufacture and deal in wires for electrical work. The capital stock is $150,000, and the incorporators are: C. E. Bibber, of Malden; C. W. Davis, of Waterville, Me.; D. A. Procter, T. H. Bibber, D. W. Dunn, all of Boston, Mass.; E. L. Brown, of Waltham; C. W. Davis, attorney, Waterville.

SWITCHBOARD FOR THE BOSTON ELEVATED.—The General Electric Cimpany has secured the contract for a switchboard for the new power house of the Boston Elevated Railway Company. The contract involves between $8,000 and $10,000.

General News.

THE TELEPHONE.

KNOXVILLE, TENN.—The People's Telephone Company has increased its capital from $15,000 to $30,000.

MARTINSBURG, W. VA.—The Winchester Telephone Company's line between this city and Shepherdstown has been completed.

HUNTINGTON, IND.—The stockholders of the United Telephone Company at their recent meeting decided to extend their line to College Park.

OSHKOSH, WIS.—The Common Council has granted the Little Wolf Telephone Company a 30-year franchise to put in an exchange here.

ITHACA, N. Y.—The Ithaca Automatic Telephone Company has been incorporated. Capital, $10,000, and directors, John P. Van Ostrand and F. S. Bronson, of Geneva.

SIOUX CITY, IA.—The Black Hills Telephone Company has asked the Sioux City Council for a 20-year franchise to connect Sioux City with other cities and towns on its line.

CHAMPAIGN, ILL.—The Home Telephone Company, of Champaign, has been incorporated. Capital, $20,000. Incorporators: W. A. Heath, D. C. Morrisey, M. Savage, all of Champaign.

ASHEVILLE, N. C.—The Asheville Telephone Company will at once extend its lines to Fairview, a distance of 10 miles. W. T. Ray, of Fairview, raised the money necessary for the enterprise.

PITTSBURG, PA.—The general offices of the Pittsburg & Allegheny Telephone Company have been removed from the Lewis block to the company's new building at Seventh Avenue and Fountain Street.

COLUMBUS, OHIO.—The Sunbury & Galena Telephone Company, Sunbury, Ohio, has been incorporated. Capital, $15,000. Incorporators: D. E. Sapp, W. C. Sapp, H. C. Devin, G. Critchfield, F. L. Beam.

ALBANY, N. Y.—The Farmers' Telephone Company, of Madison and Oneida counties, has been incorporated. Capital, $1,000. Directors: Milton Jennings, of Canastota, and R. D. Button, of Cottons, Madison County.

NEW YORK, N. Y.—There were, on May 1, 42,487 telephones in use in Manhattan Borough. This is said to be the largest telephone system in the world. There are 80,000 telephone stations in New York and vicinity.

APPLETON, WIS.—The Wisconsin Telephone Company is about to begin the work of rebuilding its entire local system. At the central exchange, improvements will be along the line of increased switchboard and toll facilities.

JEFFERSON, IA.—The New State Telephone & Telegraph Company has been chartered. Capital, $100,000. Incorporators: C. G. Cockerill, P. C. Cockerill, M. M. Head, all of Jefferson; C. H. Smith, J. Mattes, both of Sac City.

ALBANY, N. Y.—A certificate of increase of the capital stock of the Catskill Mountain Telephone Company from $5,000 to $15,000 has been filed. The company operates in the counties of Albany, Schoharie, Ulster and Delaware.

JEFFERSON CITY, MO.—The Telephone Company, of Jefferson City, Mo., issued certificates of incorporation May 12. Its capital stock is $50,000 and the incorporators are Edward T. O'Rear, Samuel B. Jeffries, J. P. Porth and others.

CLEVELAND, OHIO.—The Cleveland Telegraph Company has been incorporated. Capital, $500,000. Incorporators: G. B. Solders, D. H. Tilden, A. A. Odell, C. B. Solders, H. E. Oru, all of Cleveland, Ohio; Solders & Tilden, attorneys, Cleveland, Ohio.

PORT JERVIS, N. Y.—The Erie Railroad is introducing telephones to supplant the present telegraph system in its block signal towers. A school of instruction has been conducted at this station for the past month for the purpose of instructing men in the new system.

NEW WASHINGTON, IND.—The Ohio Valley Telephone Company is negotiating for the purchase of the New Washington and Nabb telephone line. It is the purpose of this company to establish long-distance service in every town in that part of Indiana.

SPRINGFIELD, MASS.—The Hampden Automatic Telephone Company, which recently obtained a franchise, will begin laying conduits as soon as its engineers can map out the streets. The city is being canvassed. Several hundred subscribers have been procured.

FAYETTEVILLE, N. Y.—The Madison & Onondaga Telephone & Telegraph Company is to extend its lines into Madison and through Onondaga counties. The company has purchased the line operated by Mr. D. G. Gates, of Eagle village, and intends to thoroughly equip its system.

BUFFALO, N. Y.—The strike of the Bell Telephone Company's linemen has been settled, and the men have resumed work. The agreement reached is that the men shall receive a uniform rate of $2.50 per day, time and a half for work done out of hours, and double time for Sunday work.

STAUNTON, VA.—At the meeting of the Augusta County Mutual Telephone Association the following officers were elected: Capt. C. Benton Coiner, president; Hon. J. W. Todd, first vice-president; Hon. J. W. Churchman, second vice-president; J. S. Richey, secretary; A. H. McCue, treasurer.

BOSTON, MASS.—At a special meeting of the stockholders of the New England Telephone & Telegraph Company on May 7 the question of increasing the capital stock was discussed. It was said the company intended to procure the consent of the stockholders to an increase from $15,000,000 to $20,000,000.

ROCKLAND, MAINE.—A mortgage for $500,000 against the Eastern Telephone Company has been recorded in favor of the Union Safe Deposit & Trust Company, of Portland. The telephone company has recently increased its capital from $100,000 to $500,000, with a view to extending its system throughout the State.

WABASH, IND.—A telephone line is to be constructed between this city and Huntington, and at that point will connect with the Daugherty telephone system in Northern Indiana. A line will also be built to Indianapolis, in connection with the new telephone system. A wire is now being strung to Roan from the local independent exchange. The entire joint system will be in operation in about 30 days.

GREENFIELD, IND.—Local capitalists have acquired a controlling interest of the telephone plant which operates in this city and throughout the county, and S. Y. Morrison has been elected president and W. A. Haugh, secretary. The entire system has 400 telephones in use, including the exchange in Greenville, Fortville, Ingals, and 20 toll stations. The system will at once be made metallic and two new lines will be constructed so that every point in the county will be reached.

NEW YORK, N. Y.—The Telephone, Telegraph & Cable Company, of New York, which recently purchased the plants of independent telephone companies in Westchester County, has completed its line through the boroughs of Manhattan and the Bronx, and is now up to South Street, the city line of Mt. Vernon. A large force of men is at work rushing the construction of this line so that the Mt. Vernon and New Rochelle subscribers of the company may have a New York City connection.

PITTSBURG, PA.—Mr. S. Hand Browne, vice-president of the Pittsburg & Allegheny Telephone Company, in a circular letter addressed to the subscribers informs them that his company expects to be ready for operation within 60 days. The company has spent $600,000 within the last 18 months in completing its lines in the two cities, Pittsburg and Allegheny, and it has also succeeded in obtaining franchises within most of the smaller suburban towns, thereby completing a regular network of stations in Allegheny County.

WABASH, IND.—R. W. Blount, president of the Home Telephone Company of this city, in company with Brook Sale, of Indianapolis, have located the poles for the new toll system connecting Wabash with Indianapolis via Marion. The New Telephone Company, of Indianapolis, and the Wabash Company will construct the line jointly. An independent toll line connection will also be built between this city and Huntington. The new line will reduce the rate between this city and Indianapolis below that charged by the Bell Company.

SUMTER, S. C.—A legal fight is in progress between the Telephone Manufacturing Company of Sumter and the Sumter Telephone Manufacturing Company. The former company has secured an injunction against the latter, preventing it from using the name or any similar name to that of the former. The trouble began some time ago, when F. C. Manning and C. T. Mason, who own half the stock in the Telephone Manufacturing Company of Sumter, became the prime movers in the organization of the Sumter Telephone Manufacturing Company.

WASHINGTON, D. C.—The company now trying to secure a franchise from Congress to operate an independent telephone exchange here, although well backed financially, seems unable to get the bill out of the hands of the Senate committee having it in charge, and it is rumored by knowing ones that there will be no report made by the committee this session, favorable or otherwise. The Bell Company is trying hard to kill the bill. Should the bill be favorably reported and passed the new company will in a short time put the old company *hors du combat*.

TORONTO, ONT.—By an agreement between the city of Toronto, Ont., and the Bell Telephone Company on Sept. 7, 1891, the rates for Toronto were fixed at $25 for private houses, and for business institutions $45. By an act passed by the Dominion Government on July 9, 1892, it was provided that the existing rates should not be increased without the consent of the government. Last year application was made to the government to permit the company to increase its rates, but was refused. Now, however, the company is disregarding the law and is charging its subscribers, in some cases, as high as $65 a year, and if any complain simply refuses to give the service and claims that it cannot be compelled to extend its lines. The government will probably now interfere.

ELECTRIC LIGHT AND POWER.

HASTINGS, NEB., is in the market for an electric light plant.

OXFORD, IND.—The electric light plant recently destroyed by fire at this place is being rebuilt.

CONVERSE, IND.—A recent storm wrecked the electric light plant at this place. The plant belongs to the town.

BEAVER DAM, WIS.—The Beaver Dam Electric Light Company and the Wisconsin Telephone Company are both rebuilding their entire line system.

TWO RIVERS, WIS.—The contract for the new electric light plant and water-works system has been let to C. A. Inglehart & Company, of Chicago, for $66,000.

SUMPTER, ORE.—The Sumpter Light & Power Company, of Sumpter, has been incorporated. Capital, $50,000. Incorporators: A. C. Little, E. Cannon, S. H. Belt.

CHARLOTTE, N. C.—The Buffalo Cotton Mills near Union, S. C., will install an electric light plant at the mill. A telephone line will be constructed from the mill to Union.

GOLD HILL, N. C.—Mr. W. G. Newman, of Gold Hill, will put in at once an electric light system for the town. An 85-kw dynamo has been ordered. The town will be supplied with arc lights.

AUBURN, N. Y.—The Citizens' Light & Power Company, of Auburn, has been incorporated. Capital, $30,000. Directors: G. B. Leonard, F. T. Pierson, T. H. Mather and C. D. Beebe, Syracuse.

NILES, MICH.—The Oronoko Water Power Company has incorporated for $200,000. It is the intention to put in a dam and an electric light plant, utilizing the full force of the St. Joseph River.

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LEAVENSWORTH, IND.—The Leavensworth Electric Light Company has been incorporated, with a capital stock of $10,000. The directors and officers are R. C. Arnold, Walter Seibirt and Fannie Whitcomb.

NORWOOD, OHIO.—The General Illuminating Heat & Power Company, of Norwood, has been incorporated. Capital, $100,000. Incorporators: C. W. Baker, V. E. Heintz, W. B. Stier, A. C. Nagle, M. G. Heintz.

INDIANAPOLIS, IND.—The Transcendent Light Company, of Indianapolis, has been incorporated. Capital, $50,000. Incorporators: J. L. Griffiths, J. L. Withershead, both of Indianapolis; G. Washington, of New York.

WAUPACA, WIS.—The Waupaca Electric Light & Railway Company has installed a new 150-hp compound Corliss engine and two 75-hp economic boilers in its plant, as an auxiliary to the 210-hp water wheel now in use.

PITTSBURG, PA.—At a meeting of Councils of the city of Allegheny held last week, the proposition to pass an ordinance giving the city the right to supply electric light and power to private consumers was defeated.

MINOCQUA, WIS.—A power plant located about three miles from this city is talked of. Mr. John Woodlock, who controls the electric light plant here, is the promoter. The power will be derived from the water power to be developed.

BROOKFIELD, MASS.—The Warren & Brookfield Electric Light Company has been organized, and is petitioning the different boards of selectmen in the villages of Warren and the Brookfields for the right to erect poles and string wires.

VILLEFRANCHE, FRANCE.—A new electric light and power company has been formed at Villefranche du Confluent (France). The company has purchased the blast furnaces which were situated there and intend to convert them into electric plants.

CUMBERLAND, TENN.—The plant of the Cumberland Electric Light & Power Company is being extensively improved. Several additional boilers and dynamos will be placed in the power station at once, entailing an expenditure of over $30,000.

ANDERSON, IND.—It is proposed to establish an electric light plant in the new Christian Church that is now almost completed in this city. It is an innovation, but the trustees say they will pay the expenses of the church with the plant and have money left.

SUMMIT CITY, B. C.—The Summit City Water, Light & Power Company, of Summit City, B. C., has been incorporated. This company will supply light to Summit City, and a deal for furnishing power, for concentrating purposes, to the Oro Denero mines is being negotiated.

ST. LOUIS, MO.—The Seckner Electric Light Company, which received the city contract for lighting the downtown section of the city with arc lights after Sept. 1, presented last week to the Board of Public Improvement a sample of the lamp it proposed to use on the streets.

THORNTOWN, IND.—Municipal ownership of the electric light plant has been voted on favorably by the electors of this city. For a year or more the authorities have endeavored to secure light service, but threats of injunction and damages for breach of contract have hindered them.

VANCOUVER, B. C.—London, England, and Canadian capitalists have taken up the scheme to supply the city of Vancouver, B. C., with electric power, and it is understood that the Stave River franchise has been acquired and that the work of development will be commenced without delay.

INDIANAPOLIS, IND.—The County Commissioners have awarded the contract for the engines, boilers and steam nad electric fitting for the new county power and electric light plant to Joseph McWilliams & Co., of Louisville, Ky., for $75,000. The plant is to furnish heat and light for all the county buildings.

RICHMOND, IND.—The vote on municipal ownership of the street lighting plant stood 2472 for and 492 against. The old company has made a formal offer to the city of its plant, but this is meeting with strong opposition from citizens generally. Mayor Zimmerman and the people advocating municipal ownership insist on the erection of a new plant.

PLEASANTVILLE, N. J.—The Shore Electric Light, Heat & Power Company, of Pleasantville, has been incorporated. Capital, $25,000. Incorporators: B. H. Shivers, C. H. Mann, G. B. Nye, W. E. Hunt, all of Haddonfield; E. Tredick, of Philadelphia; P. B. Riseley, of Pleasantville; H. L. Moulton, of Philadelphia; W. S. Wright, V. F. Lake, A. P. Risley, E. A. Higbee, attorney, Atlantic City.

ROCK HILL, S. C.—The Catawba Power Company, of Rock Hill, has been formally organized. Dr. W. G. Wylie, of New York, is president, and F. C. Whitner, of Rock Hill, secretary and treasurer. The company will invite bids for the erection of a dam, and an electric plant will be installed. It will probably invest $350,000 before its plans are fully developed.

ALBANY, N. Y.—The Fulton County Gas & Electric Company has been incorporated to manufacture and supply gas and electricity for lighting in Gloversville and Johnstown, Fulton County. Capital, $1,500,000. Directors: George E. Spencer, Brooklyn; John B. Summerfield, Armitage Matthews, Henry C. Everdell, New York City; James C. Young, Jersey City, N. J.

NORWALK, CONN.—The syndicate known as the Connecticut Lighting & Power Company, which already controls a majority of the trolley lines and gas and electric light concerns in the State, and which recently purchased water rights and power upon the Housatonic River, has now secured, according to trustworthy information, control of the water rights of the entire Saugatuck and Aspetuck rivers, the Southport steam, the Westport Water Company & Electric Light Company, and has formed a new organization under the name of the Southport Water Company. The syndicate proposes to have control in the entire State in the electric and gas lighting, water power and trolley systems. In Norwalk more than $500,000 is being expended in the erection of a modern gas, electric light and power plant.

NORWALK, CONN.—There is a bitter fight over the ownership of public franchises between the city of South Norwalk and the Connecticut Lighting & Power Company, the syndicate which has been gaining control of all the electric light plants, trolley roads, power plants and gas-lighting systems throughout the State. At a special city meeting on May 16 it was voted to spend $20,000 to enlarge the commercial lighting plant, while an offer of the Connecticut Lighting & Power Company of $90,000 for the plant was refused. Now the syndicate asks for an order of court to cause the city to relinquish its business or to purchase the entire plants of the lighting and power company, as the public acts of the State provide. The purchase of the plants would involve an outlay of nearly $500,000 by the city, as the company has expended about that amount on its plants in the city.

THE ELECTRIC RAILWAY.

GREEN BAY, WIS.—Employees of the Fox River Electric Railroad & Power Company have been granted an increase in wages to date from May 1.

GREENWOOD, B. C.—Contractors are now submitting tenders for the construction of eight miles of electric tramway between Greenwood and Phœnix, B. C.

EAST LIVERPOOL, OHIO.—The right of way for an electric railway to be built between this city and Vanport, Pa., a distance of 14 miles, has been secured.

SPRINGFIELD, OHIO.—The National Traction Company, which will build an electric line from Columbus to Indianapolis, has applied for a franchise through this county.

PORTSMOUTH, VA.—The Portsmouth Street Railway Company has borrowed of the Colonial Trust Company, of Philadelphia, $100,000, which will be used for betterments.

SHARON, PA.—The stockholders of the Valley Street Railway Company, of Sharon, Pa., have elected the following officers: A. M. Jolly, president; F. G. Barker, secretary, and Alexander McDowell, treasurer.

AURORA, ILL.—The Aurora, Batavia & Geneva Railroad Company has been incorporated to build an electric railway up the east side of Fox River from Aurora into Geneva, there to connect with the Elgin line.

HALIFAX, N. S.—The Cape Breton Electric Tramway & Power Company has applied to the Nova Scotia Government for incorporation. The company is asking exclusive powers to build tramways in the county of Capt Breton, N. S., for a period of three years.

WINDSOR, ONT.—United States capitalists have submitted a proposition to the municipalities to build an electric railway from Windsor, Ont., to Ruthven, and from Kingsville, Ont., and Leamington. Some of the municipalities have already granted franchises.

OGDEN, UTAH.—The Ogden, Utah, City Council recently granted a street railway franchise to a company, composed of local capitalists, who have agreed to take up the franchise held by the present street railway company and spend $35,000 in improving the system.

JERSEY CITY, N. J.—It is reported that the North Jersey Railway Company has been negotiating for the purchase of the rights and franchises of the Hudson River tunnel. The purpose of the negotiation seems to be to secure a New York terminal for the railway company's system.

VENICE, ILL.—The citizens of Brooklyn have secured an injunction against the management of the Venice & East St. Louis Electric Railway Company, preventing the company from building the line down the highway from Brooklyn unless the company grades the sides of the road.

COLUMBUS, OHIO.—The Columbus & Lancaster Traction Company has completed final arrangements with the Columbus Railway Company for the use of the latter's tracks and power in entering the centre of the city. The arrangement is under what is known to street railway people as the "Dayton plan."

NEW YORK, N. Y.—President A. E. Orr, of the Rapid Transit Commission, said that there were five demands for rapid transit before the board—Queens, Richmond and the Bronx having one each, and Kings having two. Each will have a hearing, delegations from Staten Island and South Brooklyn having been received.

NEWARK, N. Y.—The Newark & Marion Railway Company has been incorporated, with a capital of $100,000, to construct a street surface road eight miles long from Marion to Newark. Among the directors are Ernest V. Pierson, Frank D. Burgess, of Newark; Caleb L. B. Tylee, of Penn Yan, and Charles H. Scott, of Marion.

NEW HAVEN, CONN.—The United Gas Improvement Company, which recently acquired the Bridgeport Traction Company, and is after a through trolley line in this State, is behind a scheme to construct a trolley line from Moodus to East Hampton, a distance of seven miles. The trolley line will cost upward of $100,000.

PITTSBURG, PA.—At the annual meeting of the Southside Passenger Railway Company of this city, the election of officers resulted as follows: President, Harry Moore; directors, James S. McKelvy, J. C. Fisher, David Yost, Jacob Hook, W. R. Ford and A. C. Wettengel. This corporation is a subsidiary company of the Brimingham Traction Company.

CLEVELAND, OHIO.—For the first time in the history of Ohio a bid was offered on May 9 for the franchise of a street railway line on Doan Street eight miles in length. The bid was offered by P. G. Kassulker, representing the Citizens' Street Railway Company, and he offers to give 24 tickets for $1 if the franchise is given him for 25 years. He gave a bond for $35,000.

HOUGHTON, MICH.—The Houghton County Electric Street Railway Company has been organized here, with F. J. Bawden, of Houghton, president; W. A. Chapman, of New York, vice-president; Charles A. Stone, of Boston, treasurer, and Albert R. Gray, of Houghton, secretary. The company has contracted for material, machinery and rolling stock and will begin actual construction work within one week.

PHILADELPHIA, PA.—Townsend, Whelen & Co., of Philadelphia; John H. Davis & Co., of New York, and E. H. Gay & Co., of Boston, announce that first mortgage bonds of the Richmond (Va.) Railway & Electric Company may be exchanged bond for bond in a new issue for $3,000,000 in 5s of the Richmond Passenger & Power Company, which has acquired the former road.

DRAVOSBURG, PA.—A charter has been issued to the Duquesne & Dravosburg Electric Street Railway Company, which proposes to build a road two miles long in the borough of Dravosburg. The officers are: L. G. Woods, of Pittsburg, president; J. H. Gross, John Hoffman, J. H. Miller and John F. Rodgers, of Pittsburg, directors. This road will be used as a connecting link of the Monongahela Traction Company between Pittsburg and Charleroi, a distance of 25 miles.

ST. LOUIS, MO.—The strike of the employees of the St. Louis Transit Company and the St. Louis & Suburban Company began Tuesday morning, May 8, and is still continuing. There have only been a few cars run at intervals on the two roads. A number of people have been hurt, car windows have been broken and considerable railway property destroyed. An effort was made to start the cars on the Suburban road and a few have succeeded in getting through with the aid of the police.

ST. LOUIS, MO.—All work in the building line on the St. Louis Transit Company's plants in course of construction at Vandeventer and Park avenues, and Second and Salisburg streets was suspended May 8 by an order from the Building Trades' Council until the contractor having charge of the construction work agrees to pay the carpenters the union scale. About 200 mechanics are out. The carpenters demand 45 cents an hour, an advance of 10 cents per hour over the former scale of wages.

CLEVELAND, OHIO.—The work of the commission appointed by the City Council to investigate the books of the Cleveland City Railway Company has been completed and will be presented to the council during the coming week. The company claims that the average cost per passenger during the past six years has been 3.335 cents, including interest on bonds and stock, but not including depreciation. The company offers to sell six tickets for 25 cents, but it seems probable that the work of the investigation committee will warrant a demand on the part of the council for a cheaper rate.

RANKIN, PA.—The Monongahela Light & Power Company, at Rankin, has started that part of its plant which will furnish power for street railways. The lighting plant will not be ready for another month. The plant will furnish power for the Braddock, Homestead, Duquesne and Pittsburg branches of the Monongahela Traction Company, the Wilkinsburg & East Pittsburg street railway and the McKeesport & Duquesne road. It will furnish light for Braddock, North Braddock, Rankin, Wilkinsburg, Swissvale, Edgewood, East Pittsburg, Turtle Creek, Pitcairn, Duquesne, McKeesport, Dravosburg, Homestead and West Homestead.

ALBANY, N. Y.—The State Railroad Commission has granted these applications: The Kingsbridge Railway Company, of New York City, to use underground or overhead electric motive power on portions of its roads; the West Tenth Street Connecting Railway Company, of New York City, for permission to construct a street surface railway on West Tenth Street, between Sixth and Greenwich avenues; the Eighth & Columbus Avenues Connecting Railway Company, of New York City, to construct a street surface road on the Boulevard, between West Fifty-ninth and Columbus Avenue; the Fort George & Eleventh Avenue Railroad Company, of New York City, to use a conduit system.

ALTON, ILL.—Two years ago the city of Alton gave the Alton Railway, Gas & Electric Company (since so named) a contract to light the city five years. Recently there was organized in Alton the Alton Electric & Service Company, doing an electric lighting and power business in Alton. This company desires the city lighting contract, and it contends that the city had no right to give the Alton Railway, Gas & Electric Company a five-year contract, and that such a contract cannot be maintained. A resolution was introduced in the Common Council May 8, declaring the five-year contract void, and instructing the committee on lights to advertise for bids for the city lighting contract once every year. The resolution was referred to the lights' committee and city counsellor. The Alton Railway, Gas & Electric Company will take the fight into the courts and endeavor to prove the validity of the contract it now holds.

NEW YORK, N. Y.—The Brooklyn Rapid Transit Company's report to the State Railroad Commission for the quarter ended March 31, 1900, including the operations of lesser companies, is as follows:

	1900	1899.		Changes.
Gross earnings	$2,596,194	$2,437,526	Inc.	$158,668
Operating expenses	1,679,275	1,751,634	Dec.	72,359
Net earnings	$916,919	$685,892	Inc.	$231,027
Other income	75,530	90,308	Dec.	14,778
Gross income	$992,449	$776,201	Inc.	$216,248
Charges and taxes	1,074,955	1,002,554	Inc.	72,401
Deficit	$82,505	$226,352	Dec.	$143,847

A large part of the fixed charges includes rentals and interest, which go back to the constituent companies, whose stock is owned by the Brooklyn Rapid Transit Company.

THE AUTOMOBILE.

THE PAINESVILLE AUTOMOBILE COMPANY has been incorporated at Painesville, Ohio. Capital, $10,000. Incorporators: George M. Blackmore, Everett J. House, Percy K. Smith, J. P. Bordon, E. D. Hartwell.

AUTOMOBILE FUNERAL.—As a result of the cabmen's strike a funeral in Buffalo on May 18 was dependent upon automobiles. In the absence of a hearse the corpse was carried in a self-propelling undertaker's wagon. There were 15 automobiles in the procession.

AUTOMOBILES IN BOSTON.—The New England Electric Vehicle Transportation Company now has in operation in Boston between 50 and 60 electric cabs, and 15 electric delivery wagons. The orders for the delivery wagons have been duplicated, and it is stated that numbers of large companies are negotiating for the equipment of an electric delivery wagon service for them.

AUTOMOBILES IN WASHINGTON.—The Washington Electric Vehicle Transportation Company has opened its station at Fifteenth Street and Ohio Avenue, Washington, D. C. The company proposes to introduce a complete cab and delivery service. It has issued a booklet illustrating the various styles of vehicles which it will keep on hand. The schedule of rates is also given. The book is gotten up in artistic manner and, apart from its commercial character, it contains interesting reading.

DELIVERY AUTOMOBILE.—Messrs. B. Altman & Company, of New York, who were the first in the city to use automobile delivery wagons, have been making experiments in the past year looking to a more perfect type of vehicle of this class and have found a pattern which meets with their approval. The weight of the new vehicle is 4000 lbs. and it has a storage battery capacity to run it 30 miles on one charge of the battery. It is the intention of the firm to abandon the use of horses entirely in its delivery service.

NEW INDUSTRIAL COMPANIES.

CAMDEN, N. J.—The West Jersey Electric Company has been incorporated. Capital, $40,000. Incorporators: David L. Kliver, William S. Moslander, Robert A. Sheets.

THE YURGAE SIGNALPHONE MANUFACTURING COMPANY filed articles of incorporation at Milwaukee, Wis., with a capital stock of $25,000. The incorporators are Otto P. Yurgae, William G. King, John F. Burnham, Andrew T. Shea and Alfred Weller. The object of the company is to connect messenger calls with telephones, so that when a boy is called for the one desiring him may at once notify the office what he wishes to have done. The plan is expected to be valuable in hotels and in cases of fire. In the case of fires the 'phones may be attached to the alarm boxes, and the exact location of the fire given to the central fire station.

PERSONAL.

MR. E. R. KNOWLES, consulting engineer, New York, has been retained by the E. W. Bliss Company, of Brooklyn, N. Y., as consulting engineer on the electrical equipment of its new factory and foundry buildings.

MR. RALPH B. COLEMAN, formerly of Denver, Colo., has accepted the position of superintendent of the Albuquerque (N. M.) Electric Light Company, in place of Mr. William Hallowell, who has resigned to return East.

Trade Notes.

THE AMERICAN STOKER COMPANY has removed its offices from 141 Broadway to new quarters in the Bowling Green Building at 11 Broadway, New York.

THE GREAT NORTHERN PORTLAND CEMENT COMPANY, Detroit, Mich., has issued a very handsomely illustrated prospectus. Its offices are at 82 Griswold Street, Detroit.

GUTMANN WATTMETERS.—The Electric Appliance Company, Chicago, states, in answer to inquiries, that at the present time the Gutmann wattmeter is made only for alternating-current systems.

THE REPUBLICAN HOUSE, Milwaukee, Wis., has contracted for a 100-kw Western Electric generator direct connected to a Skinner engine. Mr. Charles Armstrong, of Chicago, is the consulting engineer.

THE ILLINOIS INSULATED WIRE COMPANY, Chicago, has just got out a very neat and attractive circular, containing its list of prices. It will be pleased to furnish them to any one upon application.

THE NEW EXCELSIOR DRY BATTERY MANUFACTORY has removed to 108 Greenwich Street, New York, where the company's facilities will be much larger than at its old quarters at 193 Greenwich Street.

O. K. INSULATING PAINT.—Messrs. Hubbard, Hall & Company, 213 West Fourth Street, Cincinnati, Ohio, report a rapid increase in orders for O. K. insulating paint and have recently secured several large orders for export.

CASPER, WYO.—The L. C. Sharp Machine Works, of Omaha, have just taken a contract to install a 500-light, 110-volt, direct-current lighting plant for the Casper Electric Light Company. The work is in charge of Superintendent M. C. Cook, of South Omaha.

INTERIOR TELEPHONES.—The Holtzer-Cabot Company, Brookline, Mass., in a recent pamphlet, describes in detail its interior telephone system. An interesting feature consists of a number of diagrams of connections for intercommunicating telephone systems.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., reports that its business for the month of May was 100 per cent greater than the same month last year, and 25 per cent greater than any other one general manager of the company.

MR. GEORGE F. ROHN, Milwaukee, Wis., has been awarded the contract for an isolated lighting plant for the Colby-Abbott Building. The contract includes a 40-kw Milwaukee Electric generator direct connected to an Ideal engine, switchboard and the wiring of the building.

PRESSES AND DIES.—Catalogue 12, just issued by the Ferracute Machine Company, Bridgeton, N. J., describes and illustrates a long line of press and dies manufactured by this company. The catalogue contains two double-folding sheets showing large illustrations of various machines and parts of the same.

THE SWEDISH-AMERICAN TELEPHONE COMPANY, Chicago, has moved its office and factory to larger quarters at 69, 71 and 73 West Jackson Boulevard. The change enables the company to treble its manufacturing capacity, a change which has been made necessary by the growth of its business.

MEXICAN STREET RAILWAY POWER PLANT.—The new power plant of the Electric Street Railway Company, in the City of Mexico, is the finest in that country. American machinery is used entirely. The oiling system was ordered of the Burt Manufacturing Company, of Akron, Ohio, manufacturer of the Cross oil filter.

THE BALL-BEARING PAY-OUT REEL.—The Western Electric Company, Chicago, Ill., has recently issued a bulletin on the Dicke Ball-bearing Pay-out Reel. The advantages of this reel will be appreciated by linemen in the unwinding of large coils of wire. The revolving part moves on ball-bearings, which practically eliminate friction.

SILICA GRAPHITE PAINT.—The Joseph Dixon Crucible Company, Jersey City, N. J., has issued a folder giving paint specifications calling for the use of Dixon silica graphite paint for the protection of structural steel and tin roofs. It contains illustrations of two large "sky-scrapers," the structural steel work of which is protected by this paint.

MESSRS. PARTRICK, CARTER & WILKINS, 125 South Second Street, Philadelphia, Pa., have just issued a 24-page pamphlet giving a list of hotels in the United States and Canada using their patent needle annunciators. They have also issued a leaflet telling what some prominent hotel men say about their patent needle hotel telephone annunciators.

CHANGE IN CO-PARTNERSHIP.—J. Elizabeth McIntosh has retired from the firm of McIntosh, Seymour & Company, Auburn, N. Y., having sold her interest. William B. Morrison and William I. Ferrey have entered the firm, each having bought an interest. The firm now consists of John E. McIntosh, J. Alward Seymour, William B. Morrison and William I. Ferrey.

THE HART & HEGEMAN MANUFACTURING COMPANY, Hartford, Conn., is removing this week to 32 Union Place, that city, where it will have more convenient quarters and better facilities than in its former establishment. Shipments this week and next will be a little broken in consequence of this move, but the firm expects to be in good shape again by next week.

PURDUE UNIVERSITY.—The annual catalogue of Purdue University, Lafayette, Ind., contains announcements for 1900 and 1901. It gives the usual information regarding the various courses and contains a catalogue of students, etc. Some selected views of Purdue University are published in pamphlet form. The pamphlet contains about two dozen illustrations of the buildings, interior views, etc., and shows a very fully equipped establishment.

SEARCHLIGHTS.—The Carlisle & Finch Company, Cincinnati, Ohio, reports a gratifying increase in the demand for searchlights. The firm expects to get into its new factory about June 1. It will have additional facilities for handling its rapidly growing business in gas-engine igniting dynamos and searchlights. The Carlisle & Finch Company is furnishing sparkers to practically all the larger gas-engine manufacturers in the United States and Canada.

CROSS-ARMS AND BRACKETS.—The Texas Arm & Pin Company, Beaumont, Tex., in a pamphlet recently issued, gives considerable information on the subject of cross-arms. The company is prepared to furnish untapped, long leaf yellow pine cross-arms, thoroughly seasoned and in good quality, either unpainted, painted or creosoted, carbolinium treatment or "Allardyce" treatment. It has a capacity of 10,000 arms per day. Mr. F. W. Greer is secretary and manager of the company.

INTERIOR TELEPHONES.—The Schmidt & Bruckner Electric Company, 325 Broadway, New York, has just issued an artistic catalogue describing its interior and intercommunicating telephone systems. The various styles of apparatus are clearly illustrated. The company's switchboard system is also described and illustrated, and a long list of names of users of its telephones is given, together with testimonial letters from many of them. This company manufactures and installs interior telephones for every purpose.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has issued one of the handsomest souvenirs ever seen at a similar gathering on the occasion of the Convention of the Mechanical Engineers held in Cincinnati a few days ago. The souvenir is in the form of a large book bound in gray cloth, and contains 60 fine steel engravings, showing the company's new plant in Norwood. It illustrates the various departments and all the various types of electrical machinery turned out in that extensive establishment.

THE MARYLAND TELEPHONE MANUFACTURING COMPANY has begun active operations at 217 Church Lane, Baltimore, Md. The company employs 110 persons at its factory. It has a daily output of from 90 to 100 telephones. The company will make all the instruments for the Maryland Telephone & Telegraph Company, the Wilmington Telegraph & Telephone Company, the Pittsburg & Allegheny Telephone Company and the Washington Telephone Company, and all other concerns controlled or to be controlled by the United Telephone & Telegraph Company.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati Ohio, has just issued two bulletins describing its marine lighting and power sets and railway power and generators. The marine sets, which include direct-connected, upright engines, are illustrated, together with views of the principal parts of the machines; also yachts equipped with these sets. Sectional views show the construction of the generators and a table gives the dimensions. The railway, light and power generators are treated in the same manner.

A SHOP SCHOOL.—In one of the shops of the United States Cast Iron Pipe & Foundry Company, Cincinnati, Ohio, the company has fitted up a room with drawing tables, boards and T-squares as a study room for the use of a number of its employees who are students of the International Correspondence Schools, Scranton, Pa. The class, which numbers about 50 men and includes the general manager, studies on "company time," and is supplied with drawing paper by the firm. All promotions in the shops will hereafter be made from students of this class.

THE GOODMAN MANUFACTURING COMPANY, Chicago, has purchased from the Link-Belt Machinery Company, of Chicago, the entire business of its electric mining machinery department. The entire force of the department has been taken over, the engineering staff materially increased, and the shop facilities improved, so that the Goodman Company is unusually well prepared to complete all contracts for mining machinery and supplies not fully executed by the Link-Belt Machinery Company, and to execute without delay additional orders for electric mining machines, locomotives, dynamos, motors and mining supplies.

IDEAL SPECIAL ENGINE.—In a catalogue supplement just issued by A. L. Ide & Sons, Springfield, Ill., the Ideal Special Engine is described and illustrated. This engine is provided with a flat balanced type of valve. The illustrations show that slides, rocker arms or off-sets are dispensed with and the valve driven direct from the eccentric rod. The valve is of the same form as that employed on the low-pressure cylinders of Ideal tandem compound engines. Double admission is obtained, large port areas provided and the percentage of clearance is low, thus giving an exceptional steam line and close economy. The illustrations show engines for direct connection and belt driving.

THE J. G. BRILL COMPANY, Philadelphia, has issued two artistic catalogues. One describes the "Industrial Electric Locomotive and Crane" and the other gives "a word of information" about the Brill No. 27, the "Perfect," Passenger Truck. The "Perfect" truck is very completely illustrated, both with perspective half-tone views and diagrammatic views, showing dimensions, sections, etc. There are also illustrations of cars of various electric railways throughout the country equipped with these trunks and the satisfaction they are giving is evidenced in reproductions of many testimonial letters given at the back of the catalogue.

THE PHILADELPHIA *EVENING TELEGRAM* recently published a financial and industrial review of that city. It was illustrated with portraits of prominent gentlemen connected with such enterprises in the Quaker City. Considerable space was devoted to industrial electricity and particular reference was made to the development of the Electric Storage Battery Company. The electric light, electric railway and telephone industries are also covered, as well as manufacturers of electrical apparatus. In the latter category is mentioned the Scott-Janney Electric Company. The industrial history of Philadelphia is certainly one to be proud of.

THE ELECTRIC LIGHT CONVENTION.—Cincinnati will be well represented at the convention of the National Electric Light Association in Chicago this week. The Cincinnati division of the General Electric Companies will be represented by Manager W. F. Hays, H. J. Douds and W. J. Hanley. Among others expected from Cincinnati are Manager F. D. Lawrence, of the Standard Electric Company; Samuel Glover, of the Post-Glover Company; Manager W. F. White, of the Cincinnati Edison Electric Company; C. E. Jones, of the Jones Bros. Company; Advertising Manager Bolles, of the Bullock Electric Company; E. M. Lawton, of the Lawton-Beattie Company; Thomas J. Ryan, of the Fort Wayne Electric Corporation; C. B. Humphreys, of the Westinghouse Electric Company, and Mr. Carlisle, of the Carlisle & Finch Company.

CARLOAD OF FANS.—We are advised by the New York office of the Emerson Electric Manufacturing Company, of St. Louis, Mo., that the third carload of fan motors and ceiling fans for the New York City stock arrived in New York on May 7. The company now has a well-assorted stock in New York of fan motors and ceiling fans for ready shipment. In order to keep all of its customers in the territory adjacent to New York City fully advised as to the exact condition of the New York stock, it is the company's intention to mail to all of the names on its mailing list in the Eastern territory, once every week, a report showing the exact number of each kind of motor in stock in New York City, and also show the number of each kind of motor on the road between St. Louis and New York, with the dates they were shipped from St. Louis, and the date they are expected to arrive in New York.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., is meeting with considerable success, particularly in its arc lamp department. After a long competitive test it was awarded the contract for 650 Adams-Bagnall constant-current series enclosed arc lamps by the Kansas City Electric Lighting Company. The company has also closed a contract with the Armour Packing Company at Kansas City for 200 Adams-Bagnall alternating enclosed arc lamps; with the East Side Electric Railway Company, of Kansas City, for 35 Adams-Bagnall enclosed arc lamps, five across 500 volts; with the Metropolitan Street Railway Company, Kansas City, for 30 Adams-Bagnall enclosed arc lamps, five across 500 volts; also with the B. R. Electric Company, Kansas City, for quite a large number of the A.-B. constant-potential enclosed arc lamps. The Western Company is also shipping approximately 200 lamps to every part of its territory, and it has on its books an important order for arc lamps to go to Mexico within the next 30 days.

ELECTRIC POWER IN PRINTING.—Judging from the exhibits at the Printing Exposition and Fair now being held at the Grand Central Palace, New York City, the electric motor seems to have invaded every department of the printer's business. To illustrate the variety of machines to which these motors are applied, we might mention that a Harris automatic job press, which is running off 13,200 impressions hourly at the exposition, and the large-improved two-color stop cylinder presses of R. Hoe & Co., are being run by Crocker-Wheeler motors. Planing, routing, stereotyping and wire-stitching machines shown by the Wesel Manufacturing Company are run by Lundell motors, and the Unitype Company is showing a simplex, one-man typesetter, with ¼-hp Lundell motor. The Child "Acme" cutter, the Campbell Company's "Century" press, the Emanuel Rau & Sons' fast-running envelope machine and the Walcutt Bros.' embossing machines, are all driven by Lundell motors, the Sprague Company evidently making a special feature of motors for the printing business. C. J. Bogue exhibits a very interesting line of photo-engraving lamps, both automatic and hand-feed, which attract a great deal of attention.

Record of Electrical Patents.

UNITED STATES PATENTS, ISSUED MAY 15, 1900.

[Conducted by William A. Rosenbaum, Patent Attorney, Times Bldg., N. Y.]

649,468. TROLLEY; J. H. Morey and T. R. Watkins, Trenton, Mich. App. filed Aug. 7, 1899. Consists of a conical wheel or series of wheels journaled on a cross-bar at each side of the trolley wheel and thus forming a roller of some considerable length.

649,491. ELECTRIC STORAGE BATTERY; E. A. Sperry, Cleveland, Ohio. App. filed Sept. 20, 1899. The cells are placed within a tank of water for cooling purposes, during the charge and the filling of the cell.

649,526. SAFETY SYNCHRONIZING DEVICE; J. Pearson, Minneapolis, Minn. App. filed July 3, 1899. A rotary converter having direct-current leads and alternating-current leads and interdependent circuit controllers

649,542.—Wire Coupling.

for said leads, whereby the actuation of the one will cause the actuation of the other.

649,527. CUT-OUT; Eliza Pettet, Farmer City, Ill. App. filed Nov. 14, 1899. Details of construction.

649,542. WIRE COUPLING; W. Gerard, St. Bernard, Ohio. App. filed Feb. 21, 1900. The device is particularly intended to re-establish connection between the ends of a broken wire. The ends of the wire are inserted into the coupling and the tension thereafter put on the wire tends to tighten the coupling.

649,549. ELECTRIC LIGHT SYSTEM; H. F. Roach, St. Louis, Mo. App. filed June 23, 1899. Details of an automatic switch mechanism for cutting a storage battery out and into circuit with the lights, when the speed of the dynamo changes above or below a normal.

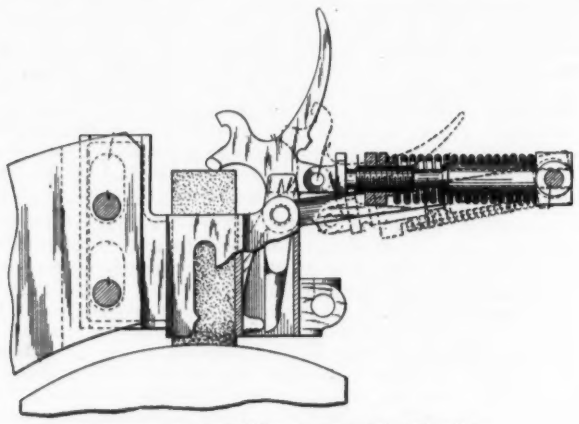
649,551. CARBON FOR ELECTRIC LIGHTS; J. F. Sanders, Portland, Ore. App. filed Oct. 14, 1897. (See Current News and Notes.)

649,552. BRUSH HOLDER FOR ELECTRIC MACHINES; H. Sawyer, Muskegon, Mich. App. filed Dec. 6, 1899. Two levers acted upon by a common spring press against the end and side of the brush respectively.

645,554. ELECTRIC SWITCH; F. Schwedtmann, St. Louis, Mo. App. filed April 8, 1899. Details of a plunger switch.

649,565. PROCESS OF MANUFACTURING CAUSTIC ALKALI AND HALOGEN GAS; C. E. Acker, East Orange, N. J. App. filed April 8, 1899. (See Current News and Notes.)

649,572. CONTROLLING AND DISTRIBUTING ELECTRIC ENERGY; F. W. Erickson, Boston, Mass. App. filed Feb. 24, 1900. The switches of a



649,552.—Brush Holder for Electric Machines.

power switchboard are moved by pneumatic motors which are electrically controlled through simple hand-operated devices.

649,574. SPACING RIB OR BLOCK FOR ARMATURE CORES; John A. Foshag, Schenectady, N. Y. App. filed Dec. 21, 1899. A spacing or separating rib for attachment to one of the laminations of an armature core, consisting of a narrow band of plate metal with lugs projecting from one edge of the band, the band being notched or cut away next the base of the lug.

649,586. CLOSED CONDUIT ELECTRIC RAILWAY; D. G. Stouchdon, Hartford, Conn. App. filed April 4, 1899. The conduit is closed by a cov ering leaf and the trolley carries a leaf opener ahead of it.

649,587. App. filed March 5, 1897. No. 649,589. App. filed March 15, 1897. No. 649,591. App. filed July 1, 1898. ELECTRIC CLOCK; S. P. Thrasher, New Haven, Conn. These inventions relate to time-indicating devices adapted to indicate the hour and the minute by figures carried upon rotating drums, which are moved by electromagnets.

649,612. PYROTECHNIC ALARM; J. C. Moore, Philadelphia, Pa. App. filed Oct. 19, 1899. This is a slow-burning torch, located on the exterior of a building and included in an electric circuit which, when completed within the house, will cause the torch to ignite and act as a signal.

649,614. APPARATUS FOR ELECTROLYSIS; Antoine Edouard Peyrusson, of Limoges, France. App. filed May 15, 1896. A double-walled porous cup contains one electrode between the walls in the form of an annular helix. The second electrode is within the inner cup and has also the form of a helix.

649,620. ELECTRIC BRAKE; C. W. Steel and W. A. Mesditt, Toronto, Canada. App. filed Feb. 27, 1899. Details of construction.

649,621. APPARATUS FOR TRANSMISSION OF ELECTRICAL ENERGY; N. Tesla, New York, N. Y. App. filed Feb. 19, 1900. (See Current News and Notes.)

649,644. CONTROLLER MECHANISM; A. E. Norris, Cambridge, Mass. App. filed Sept. 16, 1899. This is a power device applied to a motor controller, and embodies shifting mechanism by which the controller may be turned a partial rotation in either direction, at will.

649,651. ELECTRIC SIGNALING APPARATUS; F. K. Fafett, St. Louis, Mo. App. filed July 10, 1899. This is an elevator signaling device, which, in addition to the usual signaling mechanism, includes mechanism for compensating for the creep of the cable over the main drum at the top of the shaft, whereby the contact making and breaking devices are caused to bear a different relation to their co-operating parts to insure that the signals will be operated at the proper time.

649,653. BATTERY COMPOUND; Henry Blumenburg, Jr., New York, N. Y. App. filed April 24, 1899. A battery charge in a dry state, composed of an organic acid and a chlorate of an alkali.

649,654. BATTERY COMPOUND; Henry Blumenburg, Jr., New York, N. Y. App. filed Sept. 29, 1899. A solution composed of sulphate of ammonia and chlorid of ammonia.

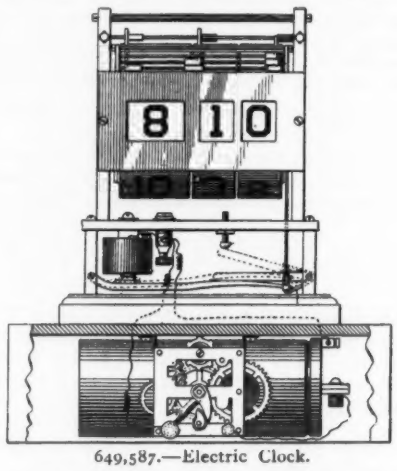
649,699. SYSTEM OF MOTOR CONTROL; Carl W. Larson, of Schenectady, N. Y. App. filed March 30, 1900. Means are provided for so controlling the circuit connections between a motor and its source of supply that the circuit will be opened whenever a device operated by the motor reaches a certain definite position. The system is described with reference to an electrically-operated drawbridge.

649,707. ELECTRIC METER; W. H. Pratt, Lynn, Mass. App. filed Feb. 27, 1899. An electric meter motor having an armature influenced by a plurality of electrically-independent fields, and means for adjusting the armature relatively to the fields to modify their individual effect.

649,726. PROCESS OF PROTECTING ELECTRIC HEATING CONDUCTORS; W. S. Hadaway, Jr., New York, N. Y. App. filed Jan. 26, 1898. (See Current News and Notes.)

649,767. ELECTRIC SWITCH; Frank L. Sessions, Oak Park, Ill. App. filed Sept. 5, 1899. Details of construction.

649,788. INDUCTION COIL; Halle E. Willis, of Lebanon, N. H. App. filed Feb. 14, 1900. The core of a medical coil has a double tubular shield of



649,587.—Electric Clock.

non-magnetic material. The outer tube is stationary and slotted between its ends and almost its entire length. The outer tube is adapted to be revolved and has a portion of its body cut away between its ends. When this tube is revolved, the slot in the outer tube is more or less covered, thus affecting the strength of the coil.

649,797. MEANS TO BE EMPLOYED IN ELECTRIC TRACTION; M. J. Barreau, Paris, France. App. filed July 22, 1899. (See Current News and Notes.)

649,840. PROCESS OF OPERATING PRIMARY BATTERIES AND REGENERATING ELEMENTS THEREOF; H. K. Hess, A. J. Shinn and C. Hering, Philadelphia, Pa. App. filed Dec. 6, 1899. (See Current News and Notes.)

649,841. PROCESS OF OPERATING TWO-LIQUID PRIMARY BATTERIES AND REGENERATING ELEMENTS THEREOF; H. K. Hess, A. J. Shinn and C. Hering, Philadelphia, Pa. App. filed Dec. 6, 1899. (See Current News and Notes.)

649,868. TELEPHONE EXCHANGE SYSTEM; W. D. Gharky, Philadelphia. Pa. App. filed April 21, 1899. Improvements in supervisory devices.

649,893. PRINTING TELEGRAPH; J. Stockert, Kothen, Germany. App. filed Dec. 5, 1899. Structural details.